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SCIENCE EDUCATION

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PROTECTIVE PRECAUTIONS IN THE HANDLING OF RADIOACTIVE MATERIALS *

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INTRODUCTION

The biological effect produced by radiation is the combined result of the production of ion pairs in tissue, and the excitation of atoms or molecules by radiation which does not have sufficient energy to cause ionization. These ionizing events upset chemical equilibrium and interfere with the normal process of cellular metabolism.

Gamma rays are usually thought of as energy quanta with great penetrating power, which produce some ionization in tissue, resulting in the loss of energy. Specific ionization is an important factor in determining biological damage. Alpha and beta particles produce ionization over the entire range of their path. For example an alpha particle produces over 400 times as many ion pairs per cubic centimeter of path in air as a beta particle, and consequently produces more damage to the tissue.

The problem of tolerance dose is largely concerned with the radiosensitivity of the tissues. Not only do different tissues vary greatly in this sensitivity, but species and even organisms react differently to the same ionization dose of radiation. The sensitivity of tissue is affected by differentiation, growth rate, and cellular environment.

Since there are so many variables in the radiosensitivity of different animal species and since much biological data on tolerance dose has been obtained from lower animal studies and isolated studies of groups of people who have been habitually exposed, the values cannot be set with absolute certainty; therefore, a generous safety factor has been applied.

The tolerance value, or maximum permissible exposure, of χ- and gamma radiation is measured in roentgens. The roentgen (r) is that quantity of χ- or gamma radiation which falling on dry air under standard conditions produces ionization to the extent of 1 esu (electro static unit) of charge of either sign per cubic centimeter. Since the element of time is involved in radiation exposure, it is customary to measure radiation in roentgens per hour (r/h) or milliroentgens (1/1000 r) per hr (mr/hr).

A roentgen of χ- or gamma radiation when absorbed in tissue produces 83 ergs per gram of tissue. Since the roentgen is used to designate only χ- or gamma absorption, the term roentgen equivalent physical (rep) is employed for the equivalent rate of absorption produced by other types of radiation.

The effect on the tissue of equivalent

* This paper was presented at the Conference on the Use of Radioactive Isotopes in Agricultural Research, held at the Alabama Polytechnic Institute, Auburn, on December 18, 19 and 20, 1947.

energy absorption of different types of radiation varies for beta, gamma, etc. Thus the unit roentgen equivalent man (rem) is used to designate the amount of radiation which produces the same damage to man as one roentgen of χ- or gamma radiation.

The maximum permissible exposure value is taken as 0.1 rem per 24-hour day. The maximum permissible exposure levels used at Clinton National Laboratory are shown below:

TOLERANCE OR MAXIMUM PERMISSIBLE EXPOSURE TO RADIATION AT CLINTON LABORATORIES*

Type of Radiation	mr/day	mrep/day †	mrem/day †	Flux for 24 hour Exposure
χ or gamma rays....	100	100	100	2200 photons of 1 Mev/cm²/sec
Beta rays	...	100	100	32 β/cm²/sec
Fast neutrons	...	20	100	66 neutrons of 2 Mev/sec
Thermal neutrons	...	~50	100	1500 neutrons of 0.02 ev/sec
α rays	...	10	100	0.0007 α/cm²/sec

* Morgan, K. Z., *Engineering Journal of Canada* (in press).

† These two units were introduced into project literature by H. M. Parker of Hanford, Washington.

Even though the maximum permissible exposure value has been set with a large factor of safety, it behooves everyone working with radioactive materials to exercise adequate precautions. Therefore, any organization which initiates a radioisotope program must assure adequate health protection for everyone who works with radioactive materials. It must provide adequate laboratory facilities which insure protection of personnel who work with radioactive substances, proper radiation detection instruments, protective clothing, and accessory apparatus; and the institution should insist that all personnel are properly trained in safe techniques in the manipulation of apparatus and in radiochemical "asepsis" and radiation survey operations. Also it is expected that everyone working in the laboratory will become familiar with the operation of health-physics survey and monitoring instruments.

The body may be irradiated from internal or external sources. Internal radiation emanates from sources which get into the body by inhalation, ingestion, and incision. External radiation can be minimized by controlling such factors as quantity of material, distance from the source, time of exposure, and shielding. When considering internal radiation, it is important to know the type of radiation, its energy, half-life, and biological half-life, which involves the rate of absorption, deposition, retention, and the metabolic processes.

MEDICAL EXAMINATIONS

It is extremely important that a pre-employment examination be given prospective radioisotope workers in order to prevent employment of individuals with blood dyscrasias and to establish and supply pertinent basic information to the case history. This examination should include a complete blood count by a skilled hematologist. Examinations, including blood counts, should be made at regular intervals thereafter. Although slight over-exposures will not be evidenced by changes in the blood count, deleterious effects may be detected before they become permanent.

Also, an accurate permanent record should be kept of daily exposures received by each individual. In addition, a record of air monitoring and area surveys should be kept.

PLANNING A RADIOISOTOPE LABORATORY

Before any institution initiates a radioisotope program, the isotopes and the quantities needed should be estimated. With this information available, the present laboratory facilities should be evaluated to determine whether they are adequate for this program. If the size is adequate and the arrangement is suitable, proper shielding and protective facilities may be added; but if the arrangement is unsuitable, it may be necessary to remodel the building or to construct a new one.

Henri Levy * has classed radiochemical operations into three categories:

a. Low levels, microcurie † level.
b. Intermediate levels, from 1 millicurie ‡ to 500 millicuries.
c. High levels, above 500 millicuries.

At present most agricultural and biological experimentation and medical therapy are in the low and intermediate categories. By practicing "radio-asepsis," operations involving materials within the microcurie range can usually be carried out in conventionally designed laboratories which have adequate hoods.

Considerable thought is required in planning a radioisotope laboratory. Before formulating final plans, it is often desirable to discuss the problems involved with individuals whose experience qualifies them as consultants. The size of the laboratory will depend upon the kind and activity of material handled, the type of operations performed, the number of people working in the laboratory, and the volume of work performed.

Many experts deem it advisable to have at least two rooms for work with radioactive materials: one for radiochemistry, and a second room for counting. These rooms should have no direct communication, in order to obviate the chance of contamination by thoughtless transfer of such contaminated objects as apparatus, shoes, and clothing.

When a large volume of biological assay work is being done, it may be desirable to have a special room for this work. This facilitates work and reduces the chance of false readings due to contamination of materials. Furthermore, for extended programs another room may be added for administering the radioactive materials to animals, for their autopsy, and for the initial isolation of the biological material. Also, it may be necessary to construct a room with proper facilities for storage of active materials. In some instances it may be desirable to locate an animal room nearby.

If large quantities of active materials are to be used, a small dressing room should be provided for change of street and protective clothing. Also, a shower should be available to personnel working with large quantities of active materials, for emergencies which may arise from accidental contamination. The shower should be located so that one can gain immediate entrance from the radiochemical area, even if temporarily "blinded" by an accident; and the shower head should deliver a large volume of water for rapid removal of the active material.

Even though it is desirable to have separate rooms for these operations, work with radioisotopes can be conducted in a single room, provided the work is segragated on the basis of level of activity, "radio-asepsis" is practiced, and the personnel strive to keep themselves and the laboratory immaculate.

FLOORS

The floors of the laboratory should have a smooth surface, such as linoleum. This type of covering is desired, since it is relatively easy to decontaminate, and if decontaminating procedures fail, the material is easily removed. Cracks in floors serve as a place for deposit of radioactive contaminants and, in general, are to be avoided, unless properly surfaced material can be applied in sections for easy removal.

SURFACES

All surfaces, including walls and ceilings, should be readily washable. Surfaces which accumulate dust should be avoided. Some of the industrial plastic tapes and special paints serve as excellent coverings for walls and exposed surfaces, since they may be stripped off when contaminated. One must purchase carefully tested materials, avoiding the use of those which may crack or peel off.

* Levy, H. A. "Some Aspects of the Design of Radiochemical Laboratories." *Chemical and Engineering News*, 24, 3168 (1946).

† A microcurie is defined, for purposes of this paper, as 3.7×10^4 disintegrations per second.

‡ A millicurie is defined, for purposes of this paper, as 3.7×10^7 disintegrations per second.

TABLES

Tables should be wide enough to enable one to take advantage of distance as a protective measure. There are several schools of thought on the most desirable type of table top, stainless steel being most desirable and glass proving to be satisfactory. Some people prefer to use an ordinary table top covered with paper or some other expendable cover. This arrangement may prove unsatisfactory, because contaminated areas may have to be removed with a chisel, leaving a condition which is conducive to further contamination.

SINKS

Sinks of lead, chemical stone, and stainless steel have proved satisfactory for installations which have special radioactive disposal systems. When one is working with microcurie quantities, sinks of albarene stone may serve satisfactorily; however, stainless steel is preferred. The traps should be easily accessible for monitoring and for survey during repair.

HOODS

Hoods should be of sufficient height to enable one to work over a barrier when necessary, and the base must be reinforced to support the added weight of the barrier. If absorption gas trains are to be used, the hood should be of adequate size to accommodate the apparatus. The lining and bottom should be of a non-corrosive material, such as stainless steel or lead, and should be designed to facilitate decontamination by washing. All parts of the ventilation system should be protected as in any fume hood. The air flow across the face of the hood should be 100 linear feet per minute, or greater.

Some radiochemists think it advisable to have all electrical receptables, also all air, gas, and water outlets, outside the hoods. This renders these receptables and connections accessible without involving radiation exposures and prevents their being contaminated by radioactive materials. This procedure is applicable in instances where constant changes and variance in experimentation are anticipated, but in other instances it may be advisable to have the connections located on the inside of the hood, but operated from the outside by remote control.

The exit hood duct should not only be air-tight, but it should be located or shielded to obviate the possibility of exposures from the gamma radiation. Great care must be exercised in selecting the point of discharge for this duct, so that the radioactivity in the discharged air will be adequately diluted before it sinks near the ground; and, in no instance should it be located where the discharged air will be blown into buildings. It is preferable to filter the exit air by some suitable means, such as solid filter, electrostatic precipitator, or wash system.

SHIELDING

Shields are usually required for work with active materials in greater than tracer quantities. There are two general methods of shielding: one is the "close" shielding type, in which each container of active material is shielded individually; the other is the "barrier" type, in which the active material is surrounded with a shield. The former technique is applicable to the less penetrating radiations, such as beta particles and X-rays. The barrier type shield is used when gamma radiation is encountered, the work being carried on over, around, or through the barrier. Regardless of the type of shielding used, every side of every shield must be constructed to protect all workers, above, below, or nearby. It is a grave error to assume that a wall, partition, or desk top affords sufficient shielding.

Gamma shielding calculations for a geometrically small source are based on spherical shields. The amount of secondary radiation will increase, especially for large walls, which fact may introduce errors in the calculated value. If the shield is flat and relatively close to the receptor, an additional thickness of about one Half Value Layer may be required to reduce the dosage

rate to the desired level. In practice, it is desirable to add a safety factor of 10 to the calculated value, particularly for stationary shields, since weight is of little importance. Lead, concrete, or other materials of high densities are required to effectively shield gamma radiations.

Sufficient shielding for beta particles is obtained by such transparent materials as glass and plastics. Plastics are desirable because they can be easily perforated, also molded or machined into any desired shape. Shields for bottles, graduated cylinders, flasks, etc., may be constructed of plastic to fit the particular article. The transparency of plastic shielding facilitates the handling of materials because it enables the operator to view his work while it is in progress.

When beta sources are confined in an open container, they radiate an upward cone of direct radiation. The dosage rate at a given distance varies widely with position and may be intensified to a certain extent by adding shielding around the container.

When a gamma emitter is confined in a shielded container, scattering and secondary radiations, particularly for radiations of intermediate and low energies, will intensify the dosage rate in the unshielded direction somewhat as stated above. For both beta and gamma, the dosage rate for the various processes is best determined by direct measurement.

PERSONNEL MONITORING

Everyone working with active materials should wear pocket meters and/or film meters. Films can be worn as badges for routine monitoring. For special work, film rings may be worn, or film packs may be taped to hands or any part of the body. Pocket meters have a useful range from 10 mr to 200 mr. The meters are charged, and the amount of discharge while they are worn is proportional to the radiation exposures, except for false readings. False readings are caused by insulation leakage due to dust particles and/or moisture, and rough handling. Because of the possibility of false readings, it is advisable for one to wear two meters side by side and compare the readings.

Pocket meters are easily read and are excellent for the detection of gamma rays; however, they are unsatisfactory for measuring beta particles. Film packets at Clinton National Laboratory are encased in 1 mm. cadmium shields, which cover the packet except for a small portion, which is referred to as the open window. The film packet consists of a sensitive and an insensitive film, which gives a useful dosage range from 20 mr to 20 r. The exposed film is developed and readings are made with a densitometer. The density of the film is read on the shielded and open-window portions of the film. The open-window reading gives information on the beta and gamma while the reading of the shielded portion indicates the exposure due to gamma only. The development and reading of films which are exposed to radiations is a science requiring specialized equipment and experienced personnel. There are so many variable factors that only an expert is capable of interpreting the results. Film monitoring service is now being supplied to users of radioisotopes from the facilities of the Atomic Energy Commission by Clinton National Laboratory. A similar service is supplied to the public by a private laboratory.

SAFE PRACTICES

Hand contamination can be reduced by wearing gloves and keeping the fingernails cut short. Certain rules should be formulated to prevent ingestion and contamination.

Rubber gloves should be worn during chemical manipulation involving greater than one microcurie of toxic material. This prevents contamination and absorption through the skin, and reduces the spread of active materials. If the palm and fingers have rough surfaces, gripping of objects is greatly facilitated. (Surgical technique is employed in putting the gloves on and taking them off.) Gloves of other materials will prove satisfactory for specific

operations. The hands should be washed and monitored before eating, smoking, or leaving an area where radioactive materials are handled.

No radioactive materials should be stored in food containers, and food should never be kept in a refrigerator containing radioactive materials. Food should not be eaten in a laboratory where radioactive materials are handled. Radioactive materials should never be pipetted by mouth, and glassblowing should not be practiced in a laboratory containing active materials.

Street shoes should not be worn when working with active materials, and in no case should one leave the area before monitoring his shoes. Hands and shoes may be monitored by holding near them a Geiger-Muller tube attached to a Scaler and orienting the tube for maximum geometry as it passes the surfaces.

Protective clothing should be worn by everyone performing any operation where there is likelihood of contamination. The type of clothing worn will depend upon the type of material handled and the operation performed. If there is likelihood of clothing contamination, coveralls, rubbers, caps, and gloves should be worn. Khaki clothing has proved satisfactory in some installations. When handling any type of radioactive material, one must exercise the minimum precaution of wearing a laboratory coat, and all clothing should be surveyed frequently with a Geiger-Muller tube probe. If a garment is removed for surveying, it should be spread out on a piece of heavy paper or other expendable material and surveyed carefully.

SELECTION OF APPARATUS

When performing an operation, one must exercise care in selecting suitable glassware and apparatus for each specific experiment. The search for suitable glassware for radioisotope work should not be confined to standard laboratory glassware, but the use of pyrex kitchen utensils should be explored. Adaptations of these designs may prove most useful. Tongs and other laboratory apparatus may be adapted for remote control work.

The ancient alchemist was satisfied with his primitive vials, beakers, and crucibles as he worked with problems which were less abstruse than the problems facing the chemist of the present day. Modern chemistry outdated these crude tools and created new apparatus adaptable to refined scientific investigation. With the advent of radioisotopes, a new era has been ushered in, antiquating much of the conventional laboratory apparatus. The embryonic science of radiochemistry presents a stimulating effect peculiar to itself, in that every operation is a challenge to the ingenuity of the chemist to devise, create, and adapt an entirely new kind of apparatus, one that can be manipulated by remote control.

The radioisotope worker is now at the point in developing methods where the bacteriologists were thirty-five years ago. Just as the bacteriologist perfected techniques in the development of bacterial-asepsis, the radioisotopologist and health-physicist are striving to perfect techniques in "radio-asepsis." This development must eventually lead to new laboratory apparatus and perfected techniques which will place the radioisotope research tool on a par with such laboratory instruments as the microscope.

PLANNING AN OPERATION

In order to keep exposure to the minimum, one should determine the time required for each part of the operation and roughly estimate the dosage rate and dosage involved. An operation should be planned to the point of determining every movement involved. Shielding should be adapted to the specific operation and remote control apparatus, if needed, should be assembled, with mirrors at proper points to enable the operator to see his work if necessary. To insure proper manipulation of apparatus, one should test the whole operation in a "dummy run," analyze and adapt *every* step to minimize exposures, and perfect techniques through other "dummy runs."

Before any operation is performed, all surfaces over which radioactive materials are to be handled should be covered with paper or some other expendable absorbent material, preferably with an absorbent surface on one side and an impervious surface on the other side. Steel or porcelain trays should be used freely, especially for holding contaminated apparatus. Glass containers should be inclosed in a second container of stainless steel or similar material.

When radioactive materials are open to the atmosphere in solution or powder form, or if gases are present, they should be stored in a hood and should not be transferred before being adequately inclosed.

One should be familiar with the physical properties of the particular isotope or compound being used. If the compound is volatile or in powder form, most operations should be performed in a hood or a closed system. Even when non-volatile substances are heated, the material may be sprayed into the air when small gas bubbles break at the surface of a liquid. The methods employed in monitoring the air may vary according to the nature of the material. Some practices which have been followed are mentioned below.

If the material is volatile, air samples may be collected in evacuated cylinders and counted with suitable counters. If it is in powder or particulate form, the air samples should be collected with an electrostatic precipitator or an air filter. When the precipitator is used, the active material is precipitated on an aluminum foil, which is counted with a shielded counter. In the case of the air filter, the air is drawn through a paper filter, and the filter is counted as explained above or by any other suitable method.

All grinding, milling, or sanding of radioactive material should be done in a hood or closed system, and it is preferable to keep the materials covered with water or other suitable agent. The maximum permissible air tolerance for beta-gamma radioisotopes has been set at 10^{-7} microcuries per cc of air.*

MONITORING AN OPERATION

Operations involving beta or gamma emitters should be monitored with a suitable instrument, preferably of the ionization chamber type. Some of these instruments are: Cutie Pie Meter, Zeus Meter, and the Quartz Fiber Electroscope. To interpret the readings, one must know the energy of the calibration source, since most instruments are energy-dependent. It is a good practice to determine some of the limitations of an instrument by testing it with a known source of radioactivity.

Surveying instruments are usually calibrated with the chamber "bathed" in radiations, and true readings are obtained only when the chamber is so "bathed." If a radiation beam has a cross-sectional area less than the cross-sectional area of the center of the chamber, the instrument reading should be corrected. (The cross-sectional area will depend upon the position of the chamber relative to the beam.) To correct the reading, one should determine the ratio of the cross-sectional area of the center of the chamber to that of the impinging beam at this point. The reading multiplied by this value will give the corrected reading. For example, an instrument chamber whose cross-sectional area at the center of the chamber is 12 square inches shows a reading of 100 mr/hr for an incident beam whose area at the center of the chamber is 3 square inches. The corrected reading is $12/3 \times 100 = 400$ mr/hr. Due to scattering, and the fact that the sensitivity of certain instruments will vary for different portions of the chamber, this correction is only an approximation. A reading corrected in this manner is usually sufficiently accurate for ordinary dosage rate measurements.

One should follow the policy of never working with radioactive material without

* AEC Regulation, Safety No. 3, "Standard Safety Requirements," April 28, 1947, page 245.

first determining the dosage rate in areas where personnel are present or are likely to be present. Before making a survey, the instrument should be "zeroed" and, in the case of the Cutie Pie and the Zeus meters, properly "warmed up." If the indicator of one of the latter instruments goes off scale on the least sensitive scale, the surveyor must back off until the level of radiation is within the calibrated range. An "off scale" reading is meaningless in the sense that it could be 1 mr/hr or 1,000,000 mr/hr greater than the dosage rate which the calibrated scale will measure. In order for a reading to be meaningful, the position and distance from the source must be noted and, for beta measurements, whether the window is open. Distances from point sources are measured from the center of the instrument chamber to the center of the source. When one is dealing with sources other than point sources, the distances are measured usually from the center of the chamber to the surface of the source. This fact must be kept in mind when one is surveying an object with which the hands are to come in contact.

The dosage rate due to each radiation component of a beta-gamma emitter can be estimated with the above-named survey meters by the following procedure:

1. Take the reading with the instrument chamber window open.
2. Close the instrument window.
3. Take the second reading with exact duplicated geometry.
4. Subtract the second reading from the first.

The value obtained in step four is an estimate of the dosage rate due to beta alone, while the value obtained in step three is due to gamma alone. These instruments are usually calibrated with a gamma source; therefore, readings caused by beta particles are only approximations.

Surveyors must be sure that the point of maximum dosage rate is surveyed and that the instrument chamber is oriented for maximum geometry; i.e., so that the maximum fraction of radiation penetrates it. They must note the relative positions of parts of the body with respect to the field of radiation and slowly move the instrument until the maximum reading in an area is obtained, paying particular attention to positions of the hands. The person of the individual performing the operation should be monitored, rather than the active material.

Each step in a chemical operation involving greater than "tracer" amounts should be surveyed to determine the maximum dosage rate. The salient points in the survey of a typical operation involving a gamma emitter are discussed below. The instrument chamber is placed at a point where the surface will be touched by the hands. After the material has been poured into the separatory funnel, a second reading is taken at the point of the stopcock. After filtering is complete, the precipitate is surveyed. The filtrate is also surveyed.

When the dosage rate to which any part of the individual will be exposed has been determined, his working time is computed on the basis of 100 mrep per working period of a 24-hour day. If an individual accidentally receives an exposure greater than 100 mrep in any 24-hour period, he should avoid radiation for a period of time sufficient to prorate the exposure on the basis of tolerance level. Experiments * have shown that in many operations involving beta emitters the hands receive from 100 to 1,000 times as much radiation as the chest, if no special precautions are observed. With proper techniques, the hand-to-chest ratio was about three.

SURVEYING AN AREA

The laboratory and area in which radioactive materials are handled should be surveyed for radioactive contaminants at least once each week. The survey should also include any other area where there is a possibility of radioactive contamination due to transfer of active materials. In areas where beta (other than low energy) or

* Tompkins, P. C. "Laboratory Handling of Radioactive Material; Protection of Personnel and Equipment." *Journal of the American Chemical Society* (in press).

gamma emitters are used, the survey should be made either with a portable beta and gamma Geiger-Muller Count Rate Meter, Audio-Detector, a Geiger-Muller Tube Probe attached to a Scaler, or other suitable sensitive detectors (less than one mr/hr). Attention is called to the fact that Geiger-Muller tubes are also energy dependent. Surveys for low-energy betas, such as those emitted from C^{14} and S^{35} can be made with a thin mico-window (less than 0.4 mg/cm^2) Geiger-Muller Tube attached to a Scaler, Count Rate - Meter, or other suitable instrument.

A Geiger-Muller Rate Meter or Audio-Detector should always be "warmed up" properly before it is taken into the field of radiation. When surveying with Audio-Detectors, one must be alert for "block-outs" or silencing due to continuous discharges which are caused by an intense field of radiation.

When radioactivity is detected, one can locate the source by selective shielding. After the type and level of radiation have been determined, the contaminated area should be marked or roped off and proper danger signs posted until the area is decontaminated. A wax pencil will serve to mark the contaminated area and to record the type of radiation and the dosage rate in the proximity of the contaminated points.

DECONTAMINATION

In case of a major spill of active material, the quantity, activity, and nature of the spilled material will determine the extent and type of monitoring needed. The contaminated area should be roped off or the door should be guarded until the material is cleaned up. If the spill is in powder form or is dissolved in a volatile solvent, all unnecessary personnel should be evacuated immediately.

In a room where a spill has occurred, one should assume that the air is contaminated. Consequently, he should wear an assault mask (U. S. Army type) or other suitable respirator when collecting air samples for counting, or performing other work. After safe working conditions are determined, or adequate protective precautions are taken, the material should be removed with some highly absorbent material and put into the "hot" can for proper disposal. When the material is in powder form and the chemical properties are known, it is sometimes advisable to wet it down with a viscous liquid, such as oil, to prevent spread and reduce air contamination.

Research institutions should find it practical to hold contamination of the laboratory, equipment, and personnel to a level far below the maximum permissible levels which have been established at some of the larger installations.

Some maximum permissible levels for beta and gamma emitters, with relation to surface, clothing, and body contamination, are shown in the following table:

TOLERANCE LEVELS FOR BETA AND GAMMA EMITTERS *

Item	Instrument	Tolerance Level
Table tops, floors, etc.	G.M. probe counter	300 counts/min with counter in contact (approx. 0.1 mr/hr at counter)
Smear test on table tops, floors, apparatus, etc.	2 sq. in. filter paper smear over 12 sq. in. and counted with Beta and Gamma and Alpha counters	o disintegrations/min of 200d counts/min of Beta and Gamma
Hand	Four fold hand counter	100 scaler units=700 counts/min$\cong$1 mr/hr of Beta and Gamma
Shoe (outside)	Foot counter	30 scaler units=10,000 counts/min$\cong$14 mr/hr of Beta and Gamma
Shoe (inside)	Shoe probe	1,000 counts/min$\cong$1/3 mr/hr of Beta and Gamma
Clothing	Laundry counter	500 counts/min$\cong$1/3 mr/hr of Beta and Gamma
Thyroid	G.M. probe counter	800 counts/min with counter against throat ($\cong$1,000 mr/24 hr in thyroid)

* AEC Regulation, Safety No. 3, "Standard Safety Requirements," April 28, 1947, page 245.

After an area is decontaminated and there are still some radioactive contaminants left, a test should be made to determine whether they will rub off the surface. This is determined by taking a smear with a two-square-inch surface of No. 50 or similar filter paper. Pressure is applied with the fingers, and a twelve-square-inch surface is smeared. The smear is counted on a counter of known geometry.

Hands are usually decontaminated by applying soap and water freely and rubbing them thoroughly with a brush. If after a thorough washing they are still contaminated, Lan-O-Kleen or similar material should be used. When contamination persists, dilute citric acid rinses should be applied, and if these fail, they may be followed by titanium dioxide paste washes. After these cleansing agents have been applied, the hands must be rinsed thoroughly to remove all traces of the materials.

Decontamination of glassware is difficult due to adsorption of radioactive material. It is necessary to wash glassware with copious quantities of cleaning solution to remove traces of active materials. Experiments by P. C. Tompkins * show that decontamination seldom exceeds 99.9 per cent efficiency and usually is between 98.0 and 99.5 per cent efficient. Glassware can frequently be decontaminated so that it does not present a health hazard.

The following ways are suggested for handling glassware which has been contaminated by radioactive materials:

1. When glassware can be decontaminated so that it does not present a health hazard, it can be re-used for experimentation involving radioactive materials.
2. If glassware presents a health hazard after decontamination, it should be properly discarded.
3. Glassware which has been used in laboratories where radioactive materials are handled should never be used for any other purpose.

Generally speaking, a thin film of the surface of a contaminated object must be removed to insure the removal of the material. One should consider the chemistry and attempt to remove the contaminant electrolytically or by the use of a complexing reagent. Chemical exchange may be employed, in which the surface is treated with a solution containing an inactive isotope of the element being removed. Glass and porcelain may sometimes be cleansed with mineral acids, ammonium citrate, trisodium phosphate, or ammonium bifluoride. Metals are sometimes decontaminated with dilute acid or ammonium bifluoride.

If clothes are contaminated with low beta and gamma activity, some contaminants may be removed by running the garments through a series of hot soapy washes and rinses. For garments contaminated with higher activity, hot 3 per cent citric acid washes may be used, in addition to the methods explained above. All garments should be monitored carefully; and if they are found to be contaminated, they must be decontaminated before being sent to a public laundry.

Contaminated expendable materials should be deposited in waterproof containers. These containers should have tightly fitting covers and should be lined with disposable absorbent material. They must be properly marked to insure against exposure of personnel and misuse of the containers. One should monitor them frequently to determine when the contents of the containers present a health hazard; that is, when the reading at the surface is 12.5 mr/hr. The contents of the containers should be properly disposed of at regular intervals and when the radiation reaches tolerance level.

DISPOSAL OF RADIOACTIVE MATERIALS

The disposal of the material will be determined by half-life and toxicity. Short

* Tompkins, P. C. "Laboratory Handling of Radioactive Material; Protection of Personnel and Equipment." *Journal of the American Chemical Society* (in press).

half-lived materials should be properly shielded and stored in a remote place for decay until the activity is negligible. However, it may be necessary to make special arrangements for disposal of intermediate or long half-lived materials: that is, materials with half-lives longer than one month.

When one is disposing of active materials in the public sewer, caution must be exercised. The nature of the active material must be carefully studied, since some radioisotopes are toxic to human beings. One must consider that by precipitation and selective absorption, the material can be concentrated by a factor of several thousand.

The disposal of animal carcasses and plant material which have been used in experiments involving radioactive isotopes presents a problem. If the material is of short half-life, these carcasses and plant materials may be stored for decay. Incineration has been suggested as a means of disposal of biological materials. Before biological material is incinerated, a special study must be made of the physical and chemical properties of the expected compounds containing the active isotope. When one has determined the compounds which will be decomposed, he should make calculations to estimate the dilution factor required to maintain an air concentration below tolerance. In order to estimate the dilution factor, one must consider the time required for burning to release the active material in the air and the rate of linear air flow across a given point of a stack of known cross-sectional area. Also, an estimate should be made of the amount of active material expected in the ashes. As an added precaution, the discharged fumes and ashes should be monitored.

Burial is another method of disposal. When this method is used, great care must be exercised in selecting the site. Materials must be covered with sufficient dirt to prevent eventual spread. If long half-lived material is buried, it should be encased in concrete or other suitable material, and the point of burial must be marked for permanent identification. A complete disposal record must be kept.

Even though every institution using radioisotopes will not have a special Health-Physics Department, every institution must have a vigorously executed Health-Physics program for the protection of laboratory personnel and the safeguard of the community.

EVALUATION OF STUDENT ACHIEVEMENT IN SCIENCE

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Introduction

THE function of science in general education is to provide rich and meaningful experiences in the basic areas of living, sufficient to enable the great majority who will not be scientists to work with those who will be, and be able to criticize or appreciate the impact of science on society. Participants in the educative process must not only know and understand the social role of science, but also increasingly secure enough understanding and ability to use the scientific method in solving the problems of everyday living, and participate effectively in a society increasingly being affected by the inventions and discoveries of science.

Achievement of this purpose means that student progress must be recorded, analysed, and evaluated in terms of the development of personal potentialities which manifest themselves throughout the educative

process. Problems of evaluation of student achievement are often solved, at least *in theory*. Indeed, an exceedingly high degree of theoretical maturity exists in developing instruments for measuring student progress in mastery of subject matter. Even in this area, some educators do not use these instruments because they do not grasp the underlying theory or educational philosophy. When, however, the educator works in terms of developing attitudes, understandings, appreciations, insights, abilities, principles, laws, concepts based on the needs, interests, and problems of young people and society, the gap between the theory and practice of evaluation is even more noticeable, especially in science classrooms.

The purpose of this paper, then, is to re-emphasize a theory of evaluation, and to present some implications of the implementation of such theory in a specific teaching situation.

The theory

Obviously, an educational approach which utilizes needs, interests, and problems of the individual is primarily a positive one; one which concentrates upon overcoming weaknesses, lacks, or deficiencies. It is often true, however, that educators using such an approach seldom divorce themselves long enough from the vitally important and absorbing task of solving problems, serving interests, and satisfying needs to concentrate upon those strong points which students already possess, but which need further guidance and educational "nourishment". This is one of the weaknesses of the "needs and problems" approach.

Further, analysis of student behavior and its isolation into parts (necessary for objective recording, observation and statistical treatment) precludes taking into full account the unity of personality which exists, and which must be recognized in order to fully understand changes in behavior which actually occur as students learn. For, it is impossible to relate the parts of individual behavior to their causes —the sum of the parts of the individual's behavior pattern is equal to more than the parts, it is equal to the entire individual, a unique, distinctive, personality with a background of experiences, level of aspiration and performance which addition of parts will not take into account. In addition, the only real and complete evaluation of the !earing process takes place in real life situations, now as a student, and later in adult life. *There is thus no surety that a sampling of student behavior in the classroom, laboratory, or test situation provides an adequate basis for evaluation of student achievement.* This point cannot be overemphasized, since one of the most powerful currents in educational theory is the belief that the educational experience cannot be valid until some measureable expression is found.

On the other hand, it is necessary to protect the student and teacher against vague and irresponsible gathering and interpretation of facts about changes in student behavior which follows the educational experience. Thus, it is necessary to formulate a program of continuous evaluation which involves record keeping from day-to-day, and a considerable individual guidance and conference with each participant in the educative process. The practical basis then for conclusions on student achievement will therefore involve analysis of what actually occurs to students during a series of learning experiences. An adequate system of records would help students, parents, teachers, and counsellors to evaluate achievement and guide student progress. Thus, evaluation should be a continuous process, and take into account the whole and functioning individual.

Techniques for securing records have been known for some time. Such techniques involve the following steps:

1. *Statement of objectives.* This indicates what is to be evaluated and defines the variety of instruments of evaluation necessary for comprehensive measurement of student achievement;

2. *Description of kinds of student behavior that indicates growth towards achievement of these objectives.* This requires the definition of specific types of situations in which students will reveal achievement or lack of it, and defines uses students make of content;
3. *Invention of methods of observing and recording behavorial changes.* This requires techniques for ascertaining progress towards achievement of objectives, determination of reliability of instruments, and discovery of observable aspects and factors accompanying significant changes in behavior, or discovery of significant behavior *per se*, and may become an index which stands for behavior.

Accordingly, the following methods may constitute one set of techniques for collecting evidences of student growth and development:

1. Examinations—paper and pencil tests
2. Anecdotal records
3. Questionnaires
4. Interviews
5. Records kept by teachers; records kept by students
6. Samples of student creative products
7. Student diaries of reading, writing, listening, speaking, thinking, and other activities including significant social activities, attitudes, and time budgets
8. Personal data sheets and interest inventories
9. Test results (IQ, personality, vocational, aptitude, and the like)
10. Write-ups of panel discussions, forums, dramatizations, and the like
11. Summaries of important discussions in class
12. Secretarial reports of what has gone on in a period of time
13. Reactions to audio-visual aids, excursions, and the like
14. Observational records of group activities, informal conversations, and the like
15. Results, analysis, and compilation of surveys, interviews, and the like.

Changes in behavior may be analyzed and classified for purposes of record keeping under listings such as follows:

Reflective thinking
- Ability to discover and define problems
- Ability to observe phenomena accurately and report accurately
- Ability to select facts relevant to a problem
- Ability to collect and organize facts
- Familiarity with reliable sources of information
- Ability to collect data
- Ability to organize data
- Ability to draw inferences from facts
- Ability to plan and test hypotheses
- Ability to apply facts and principles in new situations
- Ability to generalize
- Increase in scientific habits and attitudes

Creativeness
- Design of problems
- Improvement of activities, projects, class discussions
- Organization of materials
- Originality in presentation, reporting, discussion, imagination
- Formulation of generalizations
- Asking significant and pertinent questions

Social sensitivity
- Participation in group activities
- Understanding of pertinent problems
- Appreciation of socially significant and controversial issues
- Willingness to cooperate
- Participation in informal situations
- Participation in controlled situations
- Presentation of written and other "assigned" work
- Considerations and plans for future

Intelligent self-direction
- Efficient use of time
- Possession of clear objectives
- Possession of efficient work habits producing results
- Mastery of necessary working skills and abilities
- Elements of persistence
- Elements of originality
- Level of aspiration
- Level of performance
- Necessity for self-approval
- Necessity for approval of others

Stated in another manner, the evaluative process should be a continuous one, and in terms of the objectives set out. Such objectives, rather than in terms of subject matter and content, might well include the following:

1. Provision of opportunities for students to develop skills and competencies in:
   a. Interviewing
   b. Locating and interpreting materials
   c. Conducting surveys, and "minor research"
   d. Solving personal and social problems in terms of needs, interests, and abilities as well as in terms of background of experiences
   e. Deriving laws, principles, concepts, understandings, generalizations and the like on the basis of learning experiences
2. Provision of opportunities for students to develop and broaden their communicative skills, expressions, and media through:
   a. Reading
   b. Writing
   c. Speaking
   d. Listening
   e. Thinking and communicating ideas, principles, laws, concepts, understandings, appreciations, generalizations and the like to others

3. Provision of opportunities for students to solve problems in terms of the best available evidences, and the scientific method
4. Provision of opportunities for students to understand the place of science in society sufficient to enable them to collaborate intelligently with scientists and criticize or appreciate the effect of science on society
5. Provision of opportunities for students to develop attitudes, habits, and techniques of:
   a. Group participation, assumption of responsibilities, duties, and obligations of the individual as part of a group
   b. Individual participation in the social process
   c. Self-reliance and self-assertiveness, including aggressiveness in the face of "authority and precedence"
   d. Techniques of counter-assertion
   e. Optimum development of personality—in terms of individuality of the organism, uniqueness of the individual, worth and dignity of the individual, and respect for the personality of others.

The Practice

In order to make specific the application of this theory of evaluation it is necessary to briefly state the situation within which such practice operates.

The State Teachers College at Montgomery, Alabama has three main divisions to its program: (1) the *general education* or junior college division; (2) the *professional education* or senior college division; and (3) the *fifth year professional education* or graduate division.

The first two years of the college program consists of a broad general pattern of education designed to fit the individual into the world-society in which he lives. The Freshman year centers attention upon problems in the development of the individual, while the Sophomore year centers attention upon problems and resources of the state, region, and nation. The general education program includes (1) special elective interest courses; (2) service skills courses; and (3) general education core courses. The major effort is not that of a general survey, but organization around major living problems within the following seven areas of living:

Personal and individual development
Human and family life relationships
Socio-civic development and relationships
Recreational and creative relationships
Vocational and economic relationships
Understanding and utilizing physical environment and resources
Development of fundamental values.

This integrated-core-general education approach is the result of intensive study beginning in the year 1939–40. The State of Alabama has adopted a Core Program from the Elementary through the College years. The course under discussion, *Bio-Social Development of the Individual* has, perhaps, undergone more experimentation than any of the other integrated courses (Integrated Arts, Man and the Physical World, Communications, Socio-Economic Problems). Bio-Social integrates Biology, Sociology, Psychology, and Health materials.

Bio-Social is conducted on a "learning by doing" basis. Therefore, about seventy-five per cent of the student's time is spent in performing activities. Practical every-day life experiences are used whenever possible and are preferred to other types of activities. Wherever real life situations cannot be utilized, the attempt is to simulate real life experiences as closely as possible. Activities take the place of lectures and other formal class experiences, and teachers are in relation to students of consultants, advisors, and guidance counsellors. There is a minimum and often complete absence of lectures. All students graduating from the college must take the course, either as Freshmen, or later, in the case of transfer students—providing that their course patterns will not allow waiving the course.

Activities are grouped around central thoughts, principles, topics, or generalizations and include the following experiences:

1. Thinking about activities
2. Listening about activities
3. Reading about activities
4. Writing about activities
5. Speaking about activities.

Activities are further sub-divided into "Must Do" and "Optional" categories. All "Must Do" activities are performed by all students, "Optional" activities are elected. There is thus provided opportunity for each student to have common experiences

("Must Do" activities) and also work on something in which he is individually interested ("Optional" activities). While the "Must Do" activities constitute the minimum requirements, there are no maximum course requirements. The more "optionals" performed the higher the point honors in the course for the student. What a student does in this regard is his responsibility.

Each student must accept responsibility for:

1. Becoming clear on what to do, how to do it, why it is being done, and the results expected;
2. Making a statement or contract estimating the time-duration of each specific activity, particular activities selected, order in which they will be performed, and budget of time for each activity selected;
3. Selecting activities to be performed;
4. Becoming a member of a group working on similar activities;
5. Deriving laws, principles, concepts, understandings, generalizations and the like from the activities;
6. Performing the activities, either individually or as a member of a group;
7. Criticizing and discussing the activities.

Activities are selected on the basis of:

1. Interest
2. Need
3. Problem

If the student wishes to perform some activity not included in the provided list, he may revise, or formulate new activities. The only stipulation being that the new activity embody similar principles, skills, informations, knowledges, concepts, and the like as those activities on which the majority of students are working.

After selecting activities students:

1. Arrange their activities from the simple to the complex.
2. Ascertain what they are to do, how they are to do it, why they are to do it, and the results expected of them *before* performing any activities.
3. Make a contract for all activities (master contract) stating the sequence of performance of activities and approximate dates of completion, and an individual contract for each activity listing materials needed, date of work on activity, resources and books utilized, conferences to be held, results expected, principles, concepts, and the like to be derived.
4. Perform the activities, one at a time.
5. Work on the activities individually, or in groups.
6. Report the activities, either in writing, or through use of photographs, orally, panel discussions, dramatization, dancing, or in any other communicative medium. The provision is that not all activities may be reported in the same manner, but a variety of ways utilized so that the various communicative skills may be developed.
7. Hold conferences with the staff.
8. Request and participate in discussion groups on particular aspects of the work.
9. Derive laws, principles, concepts, understandings, and generalizations from the units work.

Staff relations to students during this period are regulated in terms of the following considerations:

1. Is the given activity important for this individual? What are the problems related to this field with which this individual will intensively and persistently be dealing during the normal course of his life?
2. What is the present state of mind of the individual under consideration? What related knowledge should he possess? What related knowledge does he already possess? What misconceptions does he entertain? What questions does he ask and what are his interests as related to this area? What does he consider worthy of study?
3. In terms of why this field is important and the present state of thinking, as well as the opinions of experienced individuals and other thinking adults, the objectives of work with this individual are set up. These objectives vary from place to place, time to time, class to class, and teacher to teacher. Nevertheless, the staff is able to work cooperatively in the given area and, in terms of stated objectives, actually *describe* thinking and acting in terms of specific situations which apply to numerous individuals. Hence, the staff is able to begin with a suggestive list of objectives, and work with students further in terms of individual needs, interests, and problems.
4. The status quo of the individuals, as revealed from analysis, and the educational objectives, suggest approaches and activities useful in aiding the students.

On the basis of the experiences of the staff in this course over some nine years of experimentation, it is now generally agreed that evaluation of student achievement must be done in terms of the objectives of education. Since it is impractical to work out specific objectives before working with the group, it is also inadvisable to work out specific evaluative instruments.

Further, the staff operates on the assumption that since educators have already placed such heavy emphasis on the teaching of factual information and evaluating the

results of such a program, and also because educators know more about facts than they do about attitudes, sound methods of thinking and the like, the techniques of evaluation of specific information have been more thoroughly investigated and developed than they have in the other more tenuous areas. With this in mind, there has been specific effort and conscious attempt to develop evaluative instruments in these "more tenuous areas".

The evaluative instrument devised, attempts to ascertain and evaluate understandings, generalizations, insights, and appreciations. It is assumed that since these educational objectives bear a definite relation to the individual's command of factual information, without such information the individual would be unable to formulate understandings, generalizations, insights, and appreciations. *Hence, it is not necessary to test for information* especially since the evaluative instrument also demands *application of principles which also presupposes a knowledge of that principle and an ability to apply it.* Furthermore, *willingness to apply principles is an attitude* and one factor which helps determine behavior.

The type of evaluative instrument used tests not only the student's ability to apply principles, but also his knowledge of these principles, and the student's understanding of relationships. Hence, *it is not necessary to resort to paper and pencil techniques.* Teachers keep anecdotal records of observations while students report, study, and perform activities. Of aid in this enterprise is the prearranged "individual contract" on which indications of the students acquisition of insights, generalizations, and the like may be quickly identified.

There is an attempt to *ascertain the extent to which learned facts, principles, and understandings are used in real problems.* Of particular value is the ability to apply to new problems the knowledge acquired in a previous situation. Likewise, the measurement of manual skills is obtainable, through collection of anecdotal records of skills exercised in the laboratory, in the preparation of classroom demonstrations and exhibits, and the like. Again, testing for the acquisition of skills throws light on the extent to which interest has been aroused. However, the direct test for the quality of a students performance is to observe the student in the act of performing the operation. This may be done with the aid of check lists such as those constructed for measuring ability to use the compound microscope.

Interest and attitude testing, as well as measurement of appreciations can best be conducted through exploration of student behavior. Behavior, however, is difficult to measure by paper and pencil tests. Hence, statements of students reactions are of use in securing indices of changes in behavior. Questionnaires may be used to determine interest changes, and interest check lists and inventories are helpful in isolating student interests. The ultimate goal is to cause students to behave in more desirable manners than they would have if they had no education.

With these considerations in mind, the following instrument is used in evaluation of students in Bio-Social:

1. With whom did you have conferences during the unit? about what?
2. Which issues, problems, needs, and interests were not adequately dealt with?
3. Which issues, problems, needs, and interests were adequately dealt with?
4. Which issues, problems, needs, and interests needed more consideration?
5. Which group discussions did you request? and participate in?
6. How much time did you spend upon various sensory experiences such as reading, writing, speaking, listening, performing demonstrations and experiments, interviewing, thinking, in "bull sessions", and various other ways (enumerate these)?
7. In what ways was this unit satisfactory and worthwhile to you?
8. In what ways was this unit unsatisfactory and not worthwhile to you?
9. How has this unit helped you plan your life through providing you with opportunities to spend some time on certain things which will indicate as important to you?
10. What personal and social problems have you solved or begun solving as a result of participation in this unit?

11. What evidences can you produce that you have reached or are reaching these solutions?
12. Which methods did you use in reporting your progress on the activities which you performed? What is the approximate percentage of time spent on each method?
13. What reading, writing, speaking, listening, and thinking competences have you developed during the course of this unit's work?
14. What things could have been done oftener? Why? What kinds of "follow-up" experiences would you appreciate next quarter?
15. Which books, magazine articles, and pamphlets did you read?
16. What generalizations did you derive as a result of participation in the unit's work (these should be stated for each area covered in the unit)?
17. What skills and competences did you acquire in performing activities?
18. Which evidences will you produce to indicate that you actually gained these skills and competencies?
19. What progress did you make in achieving understanding? Which understandings did you achieve? What evidence will you produce that you actually gained these understandings?
20. How did you change your thinking during this unit of work? What evidence will you present to indicate that these changes actually took place?
21. What informations and knowledges did you locate and interpret pertaining to the various phases of the work? What evidences will you produce that you actually located and interpreted this information and knowledge?
22. What percentage of your time was spent on the "Must Do" or required activities?
23. What percentage of your time was spent on the "Optional" activities?
24. How many "Must Do" and "Optional" activities did you perform? How many "Must Do" activities were performed individually? in a group? How many "Optional" activities were performed individually? in a group?
25. What evidences can you present that you actually performed these activities?
26. What evidences will you present that you cooperated, assumed your share of the responsibilities, performed your obligations, and otherwise functioned as a member of a group during this unit?
27. What principles and concepts did you derive as a result of participation in this unit? What meanings do these principles and concepts have for you, as reflected in changes in your behavior and thinking?
28. What is your critical analysis of past, present, and future trends in terms of the materials covered in this unit, and how does this affect your point of view?
29. What conclusions have you reached as to how and why things, events, persons, environment, points of view, and the like, influence your role and function as an individual in a complicated society?
30. Which criticisms or gripes do you have about this unit's work? What commendatory things have you to say about this unit's work?

Grades are determined by what students do. The number of activities turned in is counted. The more "optional" activities the higher the grade. The number of laws, principles, concepts, generalizations, understandings, and the like formulated is also counted. Part of the grade is therefore purely quantitative in terms of the actual amount of work done.

Grades also are determined by the quality of work done. Not only the number of things done, but also the excellence; and manner in which they were done. This is analysed in terms of the standards of achievement in reading, writing, speaking, listening, thinking, and other performance during the unit. All students are evaluated in terms of the highest and lowest levels which examination of the folders reveals to be the range for the particular student group. There is no preconceived standard, but a range is determined from analysis of all materials which all students have made available in their folders.

Grades are determined by analysis of what was done, how it was done, why it was done, and the results achieved as revealed through the levels of competence in the application of principles, laws, concepts, generalizations, understandings and the like in problem situations, and knowledge of how these apply to the individual. These applications are documented through the contents of reports turned in and teacher-staff observations throughout the unit's work. This material is also part of the contents of the student folders.

SUBJECT-MATTER TOPICS CONTAINED IN TEXTBOOKS FOR USE IN SURVEY COURSES IN THE NATURAL SCIENCES PART II.*

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STATEMENT OF THE PROBLEM

The purpose of this investigation was to determine the subject-matter topics found in textbooks for use in survey courses in the natural sciences.

TECHNIQUES EMPLOYED

Step I: Selection of textbooks for analysis. In order to differentiate the survey course from other types of courses, a definition of the survey course is necessary. Havighurst [1] defines the survey course as follows:

> A survey course is any course intended for college freshmen and sophomores primarily as part of their general education which draws its subject matter from two or more of the ordinary college departments.

In harmony with this definition, a survey course in science, then, is any course intended for college freshmen and sophomores primarily as a part of their general education, which draws its subject matter from two or more of the sciences: physics, astronomy, geology, chemistry, zoology, botany, *et cetera.* In general there may be three types of survey courses in science: (1) a survey of the physical sciences; (2) a survey of the biological sciences; and (3) a survey course including materials from both the physical and the biological sciences. A limited number of textbooks intended for use respectively in each of these three types of survey courses was available for this investigation.

On the basis of the definition of a survey course, and in particular, a survey course in science, a set of criteria was formulated for selecting textbooks representing each of the three types. From the definition, a survey course in science includes materials from two or more of the sciences. A statement was made, therefore, for each set of criteria embodying that idea and whether the two or more sciences were physical, biological, or both.

A second statement was made to express the idea that survey courses are designed as a part of the general education of those students pursuing these courses. It was assumed that that idea is implied in the expression, "survey," or "general" course. A further statement was included that expressed the purpose of science in general education.

The following criteria were formulated, by using the procedure already described, for selecting textbooks for survey courses in the biological sciences:

1. The book must present material from two or more of the biological sciences.
2. The author or authors of the book must state
   a. that it is designed for a "survey," or "general" course or
   b. that it is designed for a course, the purpose of which is to give to those students who are not planning to major in any of the fields discussed, a broad background of knowledge of the biological sciences or the biological world.

Five books were selected as satisfying these criteria. The following procedure was used in selecting each of the five books. The content of a book was examined to determine whether it contained materials from two or more of the biological sciences, thus satisfying criterion 1. Next, the preface to that book was read to determine whether the purpose of the book met part (a) or (b) of criterion 2. To be selected

* This second article is a report of one unit of a Dissertation for the Ph.D. Degree, recently completed at the University of Michigan. Part I entitled *Investigation of Student Opinion Concerning Survey Courses in Science* based on another unit of the Dissertation was published in the February, 1948 issue of *Science Education.*

[1] R. J. Havighurst, "Survey Courses in the Natural Sciences," *American Physics Teacher,* 3:97 (September, 1935).

for inclusion in this investigation a book had to satisfy both criteria.

The criteria formulated for selecting textbooks for survey courses in the physical sciences were:

1. The book must present material from two or more of the physical sciences.
2. The author or authors of the book must state
   a. that it is designed for a "survey," or "general" course or
   b. that it is designed for a course, the purpose of which is to give to those students who are not planning to major in any of the fields discussed, a broad background of knowledge of the physical sciences or of the physical world.

On the basis of these criteria eight books were selected. A procedure similar to the one that was used in selecting textbooks in the biological sciences was followed in selecting textbooks in the physical sciences.

For those survey courses in science that include material from both the physical sciences and the biological sciences, the following criteria were formulated for the selection of textbooks:

1. The book must be one presenting material from both the physical sciences and the biological sciences.
2. The author or authors of the book must state
   a. that it is designed for a "survey", or "general" course or
   b. that it is about the physical and biological world and man as a part of these worlds.

On the basis of these criteria two books were selected according to the procedure that has already been described for selecting textbooks for inclusion in this investigation.

Step II: The formulation of a composite outline of topics related to the physical sciences. The eight textbooks for survey courses in the physical sciences and the two textbooks for survey courses including materials from both the biological sciences and the physical sciences were used in this part of the investigation. The subject-matter topics contained in a textbook were considered to be its chapter, center, and paragraph headings. For each textbook an outline was formulated by fitting the headings which it contained into an outline form in accordance with the way the author or authors had arranged them in that text.

Upon inspection of these outlines, the following major divisions of the physical sciences included in the textbooks became apparent: astronomy, chemistry, geology, energy including mechanics, heat, sound, electricity and magnetism, and light and color. At first it was planned to use the outline of the one textbook which by inspection seemed to have the largest number of subject-matter topics to serve as a basis for the composite outline. This plan was abandoned, however, when it was found that the textbooks varied considerably in the number and variety of topics discussed in the major divisions. In order, then, to have the largest possible number of subtopics in each of the major divisions to serve as a basis for the composite outline, it was decided to use for each major division the outline representing it in the textbook which presented the greatest number of topics dealing with that division. For example, that section of the outline of a textbook which appeared to have the largest number of subtopics in astronomy was used as a basis for the outline of astronomy; further, that section of the outline of whichever textbook appeared to have the largest number of subtopics in chemistry was used as a basis for the outline of chemistry.

Sheets, ruled with ten vertical columns at the right-hand side, were used for tabulating the frequency of appearance of topics in the several textbooks. A code letter for each of the ten textbooks was placed respectively at the top of one of the ten vertical columns. The topics from the section on astronomy of the outline of textbook (N) were written in their outline form at the left-hand side of the sheet. A star (*) was placed in the column headed by (N) opposite each topic in this section of the outline to indicate that that topic appeared in textbook (N).

When all of the topics on astronomy from textbook (N) had been entered and starred, topics from a second textbook were added to the outline in the following manner: a star (*) was placed in the column

headed by the letter code for this second textbook opposite every topic which appeared in the second textbook and which had already been entered from textbook (N).

In most cases the topics which dealt with astronomy in other textbooks were worded differently from those appearing in textbook (N). For example, "Most of the Sun's Energy Is Believed To Be Produced by Subatomic Changes," appears as a topic in one of the textbooks. The wording of this topic suggests that it is the same as the topic, "Source of the Sun's Heat," which appears in textbook (N). A rapid reading of the discussion of the former topic in the textbook in which it was found showed that it was essentially the same as the discussion of "Source of the Sun's Heat" in textbook (N); therefore, these two topics although worded differently, were considered to be the same. The following topics appearing in other textbooks further illustrate variations in the wording of this same topic: "Source of the Sun's Energy," "Source of the Energy of the Sun," "What is the Source of This Energy Which Is Radiated in All Directions by the Sun?", "What Keeps the Sun Hot," "Possible Sources of the Sun's Heat," "The Source of the Sun's Energy Is Still Unknown." Since "Source of the Sun's Heat" appears in the section on astronomy of textbook (N) which was used as the basic outline for astronomy, this wording was retained in the composite outline.

When all of the topics which the second textbook had in common with textbook (N) had been starred in the column headed by the code letter for the second textbook the remaining topics on astronomy from that book were added at appropriate places to the outline and were starred in the appropriate column.

"The Tides" appears as a subtopic under "The Moon" in the section on astronomy in textbook (N). When the discussion of this topic was read it was found that causes of tides, schedule of tides, and the effect of the sun on tides were explained; therefore, when the topic, "Causes of the Tides," appeared in the outline of another textbook, it was placed as a subtopic under "The Tides." When "Schedule of Tides" appeared as a specific topic in one of the other textbooks, it also was placed as a subtopic under "The Tides." Often the way in which a topic was worded did not offer a clue to its real meaning; however, its position in the outline of the textbook that contained it and a reading of the discussion of it provided a basis for determining where it could defensibly be placed in the composite outline. For example, "The Sun as a Factor" as a topic means little; but its position in the outline of the textbook in which it was contained and a reading of the discussion of it indicated that it was meant to designate the effect of the sun on the tides; therefore, it was placed as a subtopic under "The Tides."

When all of the topics on astronomy from the second textbook had been added, a similar procedure was followed with each of the remaining eight textbooks.

If a textbook contained a topic related to astronomy that did not appear in the section on astronomy of the outline of textbook (N), or could not be placed as a subtopic at an appropriate point, it was added at the end of the composite outline. For example, "Astronomical Measurements Are Used to Measure Time, to Fix the Calendar, and to Aid in Navigation" is a topic contained in one of the textbooks. The section on astronomy in the composite outline, however, contained neither this topic nor any other under which it could be placed as a subtopic. It was, therefore, added as a new topic at the end of the composite outline. Similarly topics from other textbooks were added to the composite outline while it was being formulated and subsequently subtopics were placed under them.

A similar method was followed in the divisions of chemistry, geology, energy including mechanics, heat, sound, electricity and magnetism, and light and color.

Chart I below illustrates the method of tabulating the subject-matter topics from the various textbooks.

CHART I

THE METHOD OF TABULATING THE SUBJECT-MATTER TOPICS FROM THE VARIOUS TEXTBOOKS

Topics	*A*	*C*	*F*	*H*	*J*	*N*	*P*	*Q*	*R*	*S*
The moon	*	*	*	*	*	*	*	*	*	*
The Tides			*		*	*		*		
Causes of the tides		*			*			*		
Schedule of the tides								*		
The sun as a factor								*		
Tidal friction								*		
Effects upon the earth						*				*
The sun, our nearest star	*	*	*	*	*	*	*	*	*	*
Source of the sun's heat	*	*	*	*	*	*		*	*	
Contraction						*				
Radioactive substances						*				
Einstein theory						*				
Astronomical measurements are used to measure time and to aid in navigation		*						*		*
Mean or local solar time			*		*			*		
Civil day										*

When all of the topics related to the physical sciences contained in the ten textbooks used for formulating the composite outline of the physical sciences had been combined according to the procedure already outlined, the composite outline was re-examined and checked by the investigator. Three copies were made and submitted to three specialists in the teaching of science. These specialists were asked to examine the outline critically to insure, first, that the position of each topic in the outline was defensible; and secondly, that no topic, although worded differently, appeared more than once in the outline unless the respective differences in its connotations at the two or more points clearly demanded that it be considered as two or more separate topics.

If one of these specialists suggested that a topic be transferred from one position in the composite outline to another, the suggestion was treated in the following manner:

1. If the topic appeared in the composite outline at the point corresponding with the one where it appeared in the outline of the textbook that contained it, the suggestion to transfer it was disregarded.

2. If the major topic under which the specialists suggested that the topic in question be placed actually contained a discussion of that topic, then the transfer was made. Major topic refers to the one whose position of relative importance in the composite outline was next above that of the topic in question. The suggested transfer was made in any case if two or more of the specialists indicated the same point for its placement in the outline.

Step III: The formulation of a composite outline of topics related to the biological sciences. The topics related to the biological sciences appearing in the outlines of the five textbooks for survey courses in the biological sciences and the two textbooks for a combined biological and physical science survey course were used in formulating a composite outline of topics related to the biological sciences.

The procedure followed was similar to that just described, except that the complete outline of a single textbook was selected to begin with rather than sections of outlines of different textbooks. This was done because the outline of this particular textbook had consistently a wider range of topics, more inclusively worded, than did that of any other textbook selected for this investigation.

Step IV: The determination of the frequency of appearance of subject-matter topics in the textbooks selected for this investigation. The final step involved the determination of the frequency of appearance of the topics contained in the two composite outlines. The frequency of any particular item was the sum of the stars (*) opposite this item in the composite outline. Chart II presenting a section of the final outline follows:

CHART II

THE METHOD OF DETERMINING THE FREQUENCIES OF THE TOPICS APPEARING IN THE COMPOSITE OUTLINES

Topics	*A*	*C*	*F*	*H*	*J*	*N*	*P*	*Q*	*R*	*S*	*Total*
The moon	*	*	*	*	*	*	*	*	*	*	10
The tides		*	*		*	*		*		*	6
Causes of the tides		*			*			*			3
Schedule of tides								*			1
The sun as a factor								*			1
Tidal friction								*			1
Effects upon the earth						*				*	2
The sun, our nearest star	*	*	*	*	*	*	*	*	*	*	10
Sources of the sun's heat	*	*	*	*	*	*		*	*		8
Contraction						*					1
Radioactive substances						*					1
Einstein theory						*					1
Astronomical measurements are used to measure time and to aid in navigation		*	*		*			*		*	5
Mean or local solar time			*		*			*		*	4
Civil day										*	1

It will be noted in Chart II that in all cases in which a minor topic appeared in a textbook, though the particular major topic under which it was placed in the outline was not specifically designated, both the minor topic and the major topic were starred. Such a procedure seems defensible, if the arrangement of topics in the outline be defensible. It is, moreover, the only means of avoiding the anomalous situation of minor topics' having greater composite values than major ones.

The complete report of this investigation contains a table that shows the individual sources and the total numbers of those sources in which the designated topics of the physical sciences were discussed. That table is too voluminous to be included here. However, the findings of that table are summarized in Table I.

TABLE I

PHYSICAL SCIENCE

DISTRIBUTION OF THE 2121 TOPICS IN THE 10 TEXTBOOKS ANALYZED

Number of Textbooks	*Number of Topics*
*10	33
9	26
8	54
7	51
6	55
5	85
4	128
3	168
2	379
1	1201

* TABLE I is read thus: Of the 2121 topics, 33 appeared in all 10 textbooks, 26 in 9, 54 in 8, etc.

1. A total of 2121 different topics was contained in the 10 textbooks analyzed.
2. It should be especially noted that of the 2121 topics only 33 were included in all 10 of the textbooks and that each of 1201 topics, or 56.62 percent of the total number, appeared in only 1 of the 10 books analyzed.
3. Of the 53 topics, which might logically be deemed major topics of the outline only, 15 appeared in all 10 textbooks, 7 in 9, 5 in 8, 4 in 7, 2 in 6, 4 in 5, 1 in 4, 1 in 3, 2 in 2, and 12 in 1.

Table II below summarizes the findings of the composite outline of topics related to the biological sciences that is set forth in tabular form in the complete report to which reference has already been made.

TABLE II

BIOLOGICAL SCIENCE

DISTRIBUTION OF THE 1589 TOPICS IN THE 7 TEXTBOOKS ANALYZED

Number of Textbooks	*Number of Topics*
*7	23
6	23
5	46
4	55
3	105
2	243
1	1094

* TABLE II is read thus: Of the 1589 topics, 23 appeared in all 7 textbooks, 23 in 6, 46 in 5, etc.

1. A total of 1589 different topics was contained in the 7 textbooks published for use in survey courses in the biological sciences.
2. Of the 1589 topics, only 23 were included in all 7 of the textbooks and each of 1094 topics, or 68.84 percent of the total number, appeared in only 1 of the 7 books analyzed.
3. Of the 11 topics, which might logically be deemed major topics of the outline only, 7 were contained in all 7 of the textbooks, and of the remaining 5, one was included respectively in 6, 5, 2, and 1 of the books.

It is apparent from the results of these two analyses that there was a lack of agreement of the authors of textbooks concerning what should be included in survey courses in the natural sciences. However, such lack of standardization is common in the earlier histories of other courses in the science curriculum. For example, analyses by Downing [1] and Klopp [2] of some of the earlier textbooks of general science and by Richards [3] on the status of biology courses in secondary schools, all reveal a lack of standardization of the content respectively in these courses.

The confusion concerning what should be included in survey courses in science is evidenced by the disproportionate number of topics which occurred only once in the 10 textbooks that were analyzed. A study that was reported by Curtis [4] showed a similar confusion concerning what should be included in general-science courses. In that study 1850 subject-matter topics in general science that were contained in 18 contributing studies were synthesized and evaluated. The data of the report of that study were presented so that it was possible to determine the number of sources which contained each of the 1850 topics. A study of these data, by the present investigator, revealed results that were similar to those of the present investigation, namely, that the majority of the topics, that is, each of 970 topics, or 52.43 percent of the total number, appeared in only 1 of the 18 contributing studies.

[1] Elliott R. Downing, "An Analysis of Textbooks in General Science," *General Science Quarterly*, 12:509–516 (May, 1928). (Curtis' *Second Digest of Investigations in the Teaching of Science*, 72–79).

[2] W. J. Klopp, "A Study of the Offerings of General Science Texts," *General Science Quarterly*, 11:236–246, (May, 1927). (Curtis' *Second Digest of Investigations in the Teaching of Science*, 70–72).

[3] Oscar W. Richards, "Present Status of Biology in Secondary Schools," *The School Review*, 31: 143–146 (February, 1923). (Curtis' *Investigation in the Teaching of Science*, 1926, 218–220).

Conclusion

Insofar as the results of this investigation may be valid, the following conclusion seems justified: There is a lack of agreement among authors of textbooks concerning the content which should be discussed in survey courses in the natural sciences (Findings of the two composite outlines as summarized in Tables I and II).

[4] Francis D. Curtis, *A Synthesis and Evaluation of Subject-Matter Topics in General Science*, Boston: Ginn and Company, 1929. Pp. 1–83.

THE HISTORY AND IMPORTANCE OF CINCHONA BARK AS AN ANTI-MALARIAL FEBRIFUGE

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Among the many contributions of botany to medicine, one of the most outstanding in importance as well as in interest is the source of quinine, Cinchona bark. Although the actual facts relating to the discovery of the medicinal uses of Cinchona bark have been fairly well established, a number of myths have grown up concerning its origin.

Supposedly, the Indians of Peru were acquainted with the bark as early as the year 1500 A.D. It has been alleged that the first accidental discovery was made by a feverish Indian who had drunk some stagnant water into which a Cinchona tree had fallen, and had long been macerated. De la Condamine, a French astronomer and one of the early investigators of the tree (1738), mentions that the bark's virtues were first noted by natives who had watched the pumas of South America chewing the bark to cure their fevers. In 1633, Calancha, a

Peruvian padre, wrote that the bark of the Fever-tree, when powdered and administered as a potion, cured fevers.

The most interesting of the legends surrounding the disclosure of the bark's properties to Europeans is found in a short novel written by Madame de Genlis, founded on the cure of the Countess of Chinchon. Translated into Spanish in 1827, this novel is called "Zuma o el Descubrimiento de la Quina—Novelda Peruana." Though factually erroneous, this account indicates the interest attached to the first introduction of quinine into Europe. The story goes as follows:

Before the middle of the seventeenth century, the Indians of South America were enslaved and cruelly treated by a Spanish Viceroy and his followers, resulting in the poisoning of his secretary. The Viceroy was recalled, and the Count de Chinchon was appointed by the court of Spain to take his place. The Indians of Lima knew well the curative properties of the Cinchona or Tree of Health, but their supreme chief, Zimeo, had them all bound to secrecy. After four months at Lima, the Countess was attacked by a tertian fever, and every known remedy was used to no avail. An Indian girl named Zuma loved the Countess dearly, but feared to reveal the secret of the sacred tree. Zuma herself contracted the fever, and the Indians gave her the powder for her own use. One night, with the aid of her husband Mirvan, son of Ximeo, Zuma crept into the Countess' room intending to administer the powder to her. The Viceroy surprised her, and concluding that the Countess was to be poisoned, he condemned Zuma and Mirvan to be burned at the stake. On the morning of the intended execution, the Countess learned of the sentence, and had herself carried to the scene. The condemned ones were released just as they were to be burned. Soon afterwards the Count rushed into the Countess' room, and announced that the Indians had divulged the curative virtues of the Cinchona bark in order to save the prisoners. The Countess was soon cured, and a great feast was held. The Viceroy had an obelisk of white marble erected at the site of the nearly-fatal pyre, and on it there was engraved in gold the words "To Zuma, the Friend and Preserver of the Vice-Queen, and Benefactress of the Old World." A Tree of Health was planted on each side to indicate the means by which the Countess had been cured.

The above legend is true insofar as the Countess de Chinchon is concerned, for she was reported to have been among the first to be cured of an intermittent fever by the bark. The following account had been accepted for many years: She had been a famous beauty at the court of Philip III, and was lady-in-waiting to Queen Margaret at Madrid. About 1636, an Indian of Malacotas revealed the medicinal secret of Cinchona bark to Don Juan Lopez de Canizares, corregidor or town governor of Loxa. In 1638, having learned of the Countess' illness, he sent a parcel of the bark to her physician, Don Juan de Vega, who administered it with great success. In 1639, the Count de Chinchon sent a scientific expedition to the Cinchona regions to collect the bark. Accompanying it was the Jesuit Cristoval de Acuna, who made illustrations and wrote extensive descriptions of the Cinchona tree. In 1640, the Count returned to Europe, and the Countess distributed the powdered bark to the fever-stricken peasants on her husband's estate. At that time malaria was endemic across central Spain, especially along the banks of the Tagus River, known today as the Tajo River.

This legend was first recorded by an Italian physician, Sebastiano Bado, in 1663. In his *Anastasis Corticis Peruviae*, he states that he had derived the story from an Italian merchant, Antonio Ballus, who had lived for many years in Peru. In 1938, an eminent Peruvian physician, Carlos Enrique Pas Soldan, published a little work entitled *Las Tercinas del Conde de Chinchon (The Fevers of the Count of Chinchon)*. According to this new version,

the fourth Count de Chinchon (Don Luis Geronimo Fernandez de Cabrera y'Bobadilla) was himself cured of malaria in 1638. His wife had not been ill at all. This account was supported by the *Diario de Lima*, a daily chronicle kept by the Count's secretary, Don José Antonio Suardo. He also states that the fourth Countess de Chinchon of the legend was not the Count's first wife, Dona Ana de Osorio (who died in Spain in 1625), but his second wife, Dona Francisca Henrique de Ribera, who died in Cartagena, Colombia, in 1639. There is no mention whatsoever of any remedy for fever in the *Diario*.

In time the bark became known as Cinchona, Chinchina, China China, Kinkina, Quinquina, and especially Pulvis Comitisse, or Countess' Powder. In Spanish America it became widely known as Cascarilla. The South American natives were said to have known it by the names Ganapride, Guananepride, Chinanepride, and Guananegine, which were probably derived from the known virtues of the remedy, and from circumstances relevant to its appearance and discovery. It may be said at this point that the word "quinine" is derived from an Indian word "quina" or "kina" meaning *bark*. The natives, unfamiliar with mortar and pestle, infused the bark in water for about a day, and thus discovered the best dose for relieving fever by trial and error.

The Quichuan or ancient Peruvian Indian name Quina-Quina belonged to the Peruvian Balsam tree *(Myroxylon peruiferum L. fil.)* before it was erroneously applied to the genus *Cinchona* by Sebastiano Bado in 1663. Therefore there is a great deal of confusion concerning the history of Cinchona bark. Peruvian Balsam bark was used as a febrifuge in Rome at the beginning of the seventeenth century under the name Quina-Quina. The descriptions of fever-bark given by Carmelite Fray Vasquez de Espinosa in Peru (1615–1628), and by the Jesuit Bernabe Cobo in his *Historia del Neuvo Mundo* (1653), match those of the Peruvian Balsam. The latter also mentions a Fever-Tree whose description tallies with that of *Cinchona*. Therefore it is clear that Peruvian Balsam bark was used as a substitute for Cinchona bark.

The word *Quina* was rendered into Italian as *China* (also pronounced *keena*) in the *Schedula Romana* of 1651, the earliest printed document relative to *Cinchona*. Even the root *Smilax China* was known as *China radix*. The name *China* was used also by Petrus Castelli (1653), Chifflet (1653), and Roland Sturm (1659). To add to the confusion, Brunacio (1661) concluded that *Quina* and *China* were one and the same, but used a new term, *Cina-Cina* in his treatise on Cinchona bark.

The English physician Gideon Harvey described the tree yielding Jesuit's bark in 1683, but it tallied with that of the Peruvian Balsam. Dale (1718) in his *Pharmagologie*, and John Ray (1686–1704) in his *Historia Plantarum* also render the description of the Peruvian Balsam for that of *Cinchona*. The confusion in descriptions was spread still more by Pomet (1694), James Petiver (1715), Leonard Plukenet (1696), and Sir Hans Sloane (1700). This confusion between the genus *Myroxylon* and the genus *Cinchona* was pointed out by E. Rosen in 1744, but no attention was paid to his clarification of the matter.

EARLY HISTORY IN EUROPE

After its introduction into Europe, the bark gained great renown. The Abbe Raynal asserts that it was known in Rome in 1639, and says that in 1640 John de Vigo (evidently the Juan de Vega, physician to the Countess de Chinchon) established the bark in Madrid at 100 *reales* per pound. The authenticity of this is doubted, since de Vega never left Peru himself. Tertian and quartan fevers were common in Rome, and by 1649 the bark was well known. This was due to the dominance of the Church, and especially to the efforts of the Cardinal de Lugo who was then Attorney-General of the Order of Jesuits. For

many years afterwards the handling of the bark was entirely done by Jesuits, and their avarice caused the entire Protestant community of Europe to ignore its properties and taboo its use. Hence the bark gained the names of Pulvis Patrum, Pulvis Jesuiticus, Pulvis Cardinalis de Lugo, and in our language, Jesuit's Bark. The physicians of Italy declined to use it, and it was kept privately in the cloisters of the nuns. Even as late as 1719 it remained in disfavor in Italy.

Francesco Petrarch, the Italian poet and humanist, severely criticized the medical profession of his age, disbelieving in their curative methods. Once, when he was ill with malaria, he was told that he would be dead the following dawn unless he kept himself awake by imbibing invigorating liquor. Instead he had a good night's sleep, and laughed at the doctors when they came in the morning to make arrangements for his funeral. In 1714 Bernardino Ramazzini wrote that it was a crime for a patient to be allowed to die of malaria when the bark was available. However, because of the widespread use of large doses of the bark, Calmenero (1647), Casati (1661), Daval (1684), and Ramazzini wrote severely against the abuse of the drug.

Cinchona bark first acquired a reputation in London in 1654. It was extensively used by the most famous practicing physician of his century, Thomas Sydenham (1624–1689) who applied himself diligently to both the treatment and description of diseases. Dr. Sydenham assumed that the bark was a specific remedy for malaria, administering it at the onset of fever, but made no determination of its chemical or physiological properties. Franciscus Torti, an Italian physician, held, in 1677, that the bark acted on the fever as an acid acts on an alkali. Many physicians of the late eighteenth century claimed that the bark did not operate on the body fluids, but on the nerves of the stomach, thence upon the entire nervous system, thus proving of value in many cases of debility.

John Evelyn, a physician and writer of about 1644, wrote that Charles II refused to take Cinchona bark for his malaria because it was not prescribed by the Church. Although he knew well the properties of the bark, Evelyn did not even administer it to his own son, who died of quartan fever in 1657.

In France the Dauphin, son of Louis XIV, was cured of chronic intermittent fever in 1679 by Sir Robert Talbor who had been physician to Charles II and was reputed to be a quack. He had imported the bark into England, and kept the remedy a secret, selling it for one hundred louis d'or per pound. (A louis d'or ranged in value from $3.84 to $5.79.) Louis XIV was also cured of malaria by drinking a concentrated mixture of the bark in wine, given him by Talbor. In 1679 the king purchased the secret remedy from Talbor for 48,000 pounds, a title, and a life annuity of 2,000 pounds. Thereafter the bark was known as "English Remedy" at Paris and Versailles.

In 1682, the French poet and writer of fables, Jean de La Fontaine, dedicated his poem "Le Quinquina" to a medical student named Anne Maria Mancini (later Madame de Buillon). She was a niece of Cardinal Mazarin, and had herself recovered from malaria by taking the bark. The poet sought her favor in order to be admitted to the academy. He praised the cures produced by the Peruvian bark , and its superiority over the practice of blood-letting in debilitated patients. Malarial fever, he said, is caused by a poison fermenting in the blood; the "bark of Apollo," best given with hot gin, neutralizes this acidity or poison in the body.

The distribution of Cinchona bark was also effected by Belgian physicians, especially Chifflet, physician to the Archduke Leopold of Austria who was Governor of the Netherlands about 1653. Michael Belga, physician to the Marquis of Mancera, Chinchon's successor, was credited with having brought the bark from Peru to

Belgium in 1650. However, it is now understood that the bark must have been known in Belgium long before that time, since it had been used by Dr. Herman van der Heyden, who in 1643 published a work mentioning that Cinchona bark, called Pulvis Medica, was then used for tertian and quartan fevers.

In India the remedy was used by a physician named Bogue as early as 1657. During 1675, over 140 pounds of the bark was used by Lind in Lower Senegal.

EARLY EXPLORATION AND INVESTIGATION

In 1735, two French botanists, Charles Marie de la Condamine (also an astronomer) and Joseph de Jussieu, led an expedition to Aviena in the forests of Loxa in Peru. The former transported Cinchona plants down the Amazon for 2,000 miles, only to lose his specimens in a heavy storm near the river's mouth. However, he published his descriptions of the plant in 1740, in the *Memoires de l'Academie.* De Jussieu studied the distribution and botanical features of the Cinchona tree for fifteen years. On the eve of his return to France, his collection of young Cinchona plants was stolen, resulting in his becoming insane.

In 1742, Linnaeus, the Swedish botanist and taxonomist, described the Cinchona tree from de la Condamine's specimens. He had learned of the Count de Chinchon from Sebastiano Bado's work, and, following the Italian spelling *Cinchon (c* being pronounced *ch),* Linnaeus erroneously called his specimens *Cinchona* in his *Materia Medica* of 1749. The Spanish botanists Hipolito Ruiz and Jose Pavon, who described many new species after explorations in the forests of Huanuco and Loxa in Peru in 1777, pointed out the error, and advocated the correct spelling as *Chinchona.* In succeeding years, explorers such as Mutis (1761), Tafalla (1778), Caldas (1802), Seeman (1846), Spruce (1849), and Markham (1852) spelled the genus as *Chinchona;* while Humboldt (1799), Poeppig (1827), Ledger (1833), Weddell (1843), Karsten (1844), Delondre (1847), Cross (1861), and Wellcome (1879) retained the spelling given by Linnaeus.

Linnaeus named two species at the time: *Cinchona officinalis panicula branchiata,* which furnished the bark in the days of the Countess de Chinchon; and *Cinchona pedunculis unifloris (C. caribea),* a native of the Carribee Islands which has since been correctly placed in the medicinally useless genus *Exostema. C. officinalis* had been called *Quina primitiva* by de la Condamine. At a later period, Kunth in Humboldt and Bonpland's *Synopsis* of 1799 changed it to *C. Condaminca.* In 1863, Sir Joseph Hooker restored the Linnaean name, but regarded *C. officinalis* as a new species indigenous to Ecuador and Peru. Weddell (1843) combined under the name *C. officinalis* the *Cinchona Chahuarguera, C. Condaminea, C. Bonplandiana, C. crispa* and *C. Uritusinga* of former systematic botanists. In 1862, John Eliot Howard translated the notes of the Spanish botanist Pavon (1800), and clarified the species of *Cinchona* in his *Illustrations of the Neuva Quinologia of Pavon.*

BOTANICAL FEATURES

The genus *Cinchona* belongs to the madder family, or *Rubiaceae.* The trees or shrubs have simple, opposite, nearly circular or lanceolate leaves bearing hairs in the young stages. The fragrant lilac- or jasmine-scented flowers may be white, rose-colored, or purple, according to the species. They are arranged in cymes or terminal pannicles, as in lilacs. Each dimorphous flower has a large tubular corolla, and is wind-fertilized.

Each capsular fruit has two valves, with a total of 12 to 38 flat, broad-winged, shield-shaped seeds which are usually light brownish-yellow in color when fertilized. A seed weighs about one-half milligram, and about 1,200 plants may result from a grain of seed. One grain of *C. Ledgeriana* yields

about 2,500 seeds, or about 75,000 to the ounce.

The Cinchona tree flowers at all seasons, and after reaching maturity, may grow flower buds, blossoms, and fruit at the same time. The fruit ripens about ten to twelve months after the buds first appear. Twigs which have borne fruit usually die. If the tree is felled, the stump can shoot up again, with a more slender stem. Although a large amount of bark may thus be produced, many of the stumped trees die.

A Cinchona tree seldom lives over fifty years, and not over fifteen years if growing in non-porous soil. Rapid growth occurs after rains and at the commencement of the east monsoon. The plants usually grow from forty to sixty inches per year in the first four to six years. Then, up to the tenth year, the growth slows down to twenty to thirty inches per year. According to the species, the circumference may increase from two to four inches annually.

Four grains of seed are sown per square meter in seed beds, and will sprout after three or four weeks if protected from bright sunlight and sprayed daily. Transfers to nursery beds are made when the plant is three or four inches tall at the end of five months, and then may be set three inches apart. Transplanting is undertaken when crowding occurs. After one to two years full resisting power will have been attained.

CLIMATOLOGICAL FEATURES

Before the Japanese captured the Dutch East Indies, over ninety per cent of the world's supply of quinine came from Cinchona trees in Java. However, since the initial habitat was in South America, a description will be given of the typical areas there.

Strictly speaking, there are no *Cinchona* forests, for the trees are dispersed in small groups throughout the forests. They are indigenous along the eastern slopes of the curving Cordillera or Andes range of mountains, extending between 10 degrees North latitude and 19 degrees South latitude. Thus the South American countries of Bolivia, Ecuador, Peru, Colombia, and Venezuela are covered in over 1,500 miles of latitude. The city of Loja (formerly Loxa), now in Ecuador, marks the extreme westerly point of the Cinchona regions, and is said to be the theoretical home of the trees. Caracas, a large town in Venezuela, marks the most northerly point, while the southerly tip of the Cinchona range is denoted by Santa Cruz in Bolivia.

The best growth takes place in a cool temperature of from 12–20 degrees Centigrade (54–68 degrees Fahrenheit), without night frosts, on mildly sloping ground, in well-drained porous soil, with a well-distributed rainfall. The best Cinchona regions in South America have been located in the foggy, deep-valley regions of the Andes, where it rains for nine months, and where the temperature is 53.6 to 55.4 degrees Fahrenheit (12 to 13 degrees Centigrade). It is here where flowers and fruit are borne simultaneously, and alkaloid formation is favored.

Cinchona trees are usually found between 5,250 and 8,530 feet above sea-level, but have been found at 3,937 and 10,730 feet, from the temperate to the cold mountain zone. Direct sunlight injures the young plant, but favors the growth of large trees, increasing the brightness of the bark. On elevations higher than 9,000 feet, Cinchona trees may be tall and branchless, or merely small shrubs.

CINCHONA SPECIES OF COMMERCIAL IMPORTANCE

Commercially, the most important species in the Netherlands East Indies, and in particular Java, is *Cinchona Ledgeriana,* with a content of from 6 to 10 per cent alkaloids, of which three-quarters is quinine. It was originally indigenous in northern Bolivia.

The species whose colorless sap turns red upon exposure to air is *Cinchona succirubra.* Called "Red Bark," because the bark occurs in rough, fibrous, reddish-brown pieces, it was grown in British India

before being transplanted to Java. It was first native on the slopes of Mt. Chimborazo in central Ecuador. At present it is used only as a stock plant for grafting with *C. Ledgeriana,* and has a total alkaloid content of 5 to 7 per cent, of which one-fifth to two-fifths is quinine. Earlier books apply the term "Red Bark" to *C. oblongifolia. Succirubra* plantings still exist in Ecuador, Colombia, and Guatemala.

A species known as *Cinchona calisava* was formerly much in use, having had a total alkaloid content of 6 to 8 per cent, of which one-half was quinine. The wild tree has almost disappeared because of the practice of chopping down the tree in order to obtain the bark. The *calisava* type of tree is native to southern Peru and Bolivia. In 1938, Bolivia exported about two million pounds of *C. salisava* bark to Europe.

C. officinalis has earned the name of "Pale Bark," "Crown Bark," "Loxa Bark," "Cuenca Bark," and "Huanuco Bark." The terms were formerly applied to *C. Condaminea.* It is covered with crustose lichens, and has a short, non-fibrous fracture. *C. Ledgeriana* is now considered botanically to be a form of *C. officinalis.*

Some species which once had some commercial importance, but are not now in use, were *C. Pelletieriana* or "Cusco Bark," *C. cordifolia* or "Maracaibo Bark," and *C. lancifolia* Mutis or "Cartagena Bark."

The alkaloid quinine is unevenly distributed throughout the tree. The bark of the trunk, branches, and roots supply the greatest amounts, more being in the branches than in the trunk. The outer layers of the bark contain more quinine than the inner, and the lower section of the trunk more than the upper.

In 1900, an investigator named Lotsy, experimenting in Java, found that seeds of *C. succirubra* and *C. Ledgeriana* contained no alkaloids. He demonstrated alkaloid content in cotyledons shortly before becoming green. Older leaves contained ten times as much alkaloid as younger leaves, with petioles richer than blades. However, he was wrong in his findings that root bark is practically free from alkaloids.

About thirty alkaloids have been isolated from Cinchona bark, the most important being quinine, followed by quinidine, cinchonidine, and cinchoninine. Standards for both the bark and the quinine are given in most National Pharmacopoeias, together with method for computing the alkaloid content.

INTRODUCTION INTO VARIOUS COUNTRIES

Due to the constant efforts of Dr. Hugo Algernon Weddell, the French government introduced the Cinchona tree into its colonies, especially Algeria, between 1845 and 1848. In 1849, the Jesuits in Cuzco in Central Peru, sent Cinchona trees to their settlement in Algeria. Although unsuccessful, these attempts attracted the attention of the Dutch.

The first attempt to introduce the Cinchona plant into Java was made by Blume in 1829, but nothing came of this. In 1854, Pahud, the Governor-General of the Dutch East Indies, sent the German botanist Hasskarl to South America with an expedition. Several hundred small trees were brought to Batavia, and then planted in Java. The first seeds were obtained from these trees in 1858, at Tjibodas, in Java. In 1865 a British merchant named George Ledger offered the seeds of the species bearing his name to the Netherlands government, and *C. Ledgeriana* became the principal source of the bark in Java. In 1899, the average yield of quinine in Java bark was four per cent, but by 1924 it had been raised to six per cent. At present it yields between four and one-half and seven and one-half per cent. In 1917, 22,800,000 pounds of Cinchona back were produced in Java. Bark from this country is marketed in Amsterdam. The annual production by Java before the Japanese captured it exceeded 25,000,000 pounds.

A British expedition to the Andes in 1859 brought back trees which were planted in India and Ceylon. Small settlements were

begun in the central mountain districts of Ceylon in 1861 at Hakgalla, at the time that the cultivation of coffee trees had begun to decline. Cinchona cultivation in Ceylon was very successful because of favorable conditions of soil and climate. Between 1885 and 1886, 15,364,912 pounds of bark were shipped from Ceylon. After 1887, due to the large-scale tea culture, the *Cinchonas* steadily declined. This decrease was hastened by British planters in Ceylon who preferred *C. succirubra* and *C. officinalis*, both with relatively low quinine yields, while Java plantation owners preferred the richer *C. Ledgeriana* which yielded more quinine.

About 1865, the forests of Bolivia were greatly exploited. The gradual extinction of the Cinchona forests of the Andes had continued until about 1852, when scientific transplantation and cultivation began. In 1859, Sir Clements R. Markham had organized an expedition to collect *C. calisava* seeds in Peru and Bolivia. Spruce had collected *C. succirubra* in Ecuador in 1849. Pritchett had obtained grey bark of *C. huanuco* in Peru. *C. calisava* had flourished in Bolivia for a long time. The annual production of the Bolivian *Cinchonas* amounted to 4,000,000 pounds in 1865. In 1864, Schuhkraft, the Dutch Consul-General at La Paz, Bolivia, had sent seeds of *C. calisava* to Java, and this species eventually contained 3.02 per cent of quinine. In 1878, plantings were undertaken in the Cinchona forests of Bolivia, the center of the movement having been the Mapiri River valleys north of La Paz.

In 1839, Dr. Forbes Royle, in his *Illustrations of Himalayan Botany* strongly recommended the introduction of the Cinchona plant into India. However, it was not until 1861 that seeds of *C. officinalis* were brought from Loxa to India by Cross, and cultivation was seriously undertaken in 1862 by MacIvor. In 1862, there were settlements at Darjeeling in the contral part of Sikkim in the southeastern Himalayas. A central point of cultivation was undertaken at Ootacamund in southern India, where elevations extend to 8,000 feet. Eventually plantations were added at Dodabetta, Kukal, Naduvatum, and Hooker in the Nilgiri Hills of Madras, near Ootacamund. Others were begun at Mungpoo and Munsong in the Darjeeling district of Bengal. Indian barks were first exported to London in 1857. India ranks second to Java in Cinchona bark production, but the yearly poundage has steadily declined since 1899–1900, when 4,000,000 pounds were produced. By 1924, it had dropped to 1,500,000 pounds annually. At present the yield is between 500,000 and 1,000,000 pounds. About thirty per cent of the plantations are operated by the British government.

In 1868, Sir J. D. Hooker introduced Cinchona trees into the island of St. Helena in the South Atlantic Ocean, off the southwest coast of Africa. There, over 600 trees of *C. succirubra* and *C. officinalis* have contributed their share to the world's production of the bark.

Before 1914, Germans planted hybrids in Tanganyika, East Africa, and they eventually yielded 8.4 per cent of quinine. There are also experimental plantations of *C. Ledgeriana* at Buea near the southeast tip of Nigeria in the Cameroons.

In 1865, small settlements were made in New Zealand, and in Brisbane, Australia, in 1866. Small plantations have also been established in the Philippine Islands, in Burma, in the Portuguese island of St. Thomas off the west coast of Africa, in Jamaica, and in Guatemala. Colombia, which fifty years ago had been an important producing center, was driven from the competitive field by low quinine yields.

In the late nineteenth century, the American Medical Association asked that a commission of five scientific men be appointed to determine whether any part of the United States had suitable conditions for growing Cinchona trees, in order to furnish additional revenue. The United States minister in Ecuador obtained seeds of *C.*

succirubra and *C. Condaminea,* which germinated in 1864 in Washington, at the experimental gardens of the Department of Agriculture. However, the plants were weak because of unfavorable growing conditions, and nothing further was done about the matter. Dr. Thomas Antisell suggested in 1869 that favorable localities might be found toward the frontier of Mexico, below the zone of the Sequoia trees; however, no suitable growing regions have as yet been located in the United States.

COLLECTION OF CINCHONA BARK

Several former methods of bark collection have generally been abandoned. "Mossing" was first discovered by William Graham MacIvor, director of the Cinchona plantations at Ootacamund, British India, in 1870. It consisted in the division of the bark into strips about four centimeters wide without impairing the cambium layer. Before the latter dries, the stripped area is covered with moss, and new bark is formed. With this method regrowth was not rapid, and resistance to parasites and insect larvae was lowered. In 1880, J. C. Bernelot Moens in Java suggested scraping or shaving the outer bark, but this was also weakening. "Coppicing," customarily employed in Java and Ceylon, consisted in felling the tree six inches above the ground when eight years of age. Side-shoots developed, and the procss was repeated after another eight years. However, the bark of the new sprout was thin, and frequently the stumped trees died.

At present uprooting the entire tree gives the best results. In South America, the "cascarillos" make longitudinal and transverse incisions in the bark with sharp knives, and the bark is loosened. When fresh the strips are flat, but in drying they curl into quills. Drying, sorting, and packaging are usually performed on the spot. In Colombia drying is accomplished in large flat boxes over fires, yielding "factory" bark or "manufacturer's" bark for use in preparing quinine. In Java, sun-drying is practiced, yielding "pharmaceutical" or "druggist's" bark which is used in making decoctions, infusions, extracts, powders, tinctures, wines, etc. When marketed, the bales or bags of quills or flat pieces weigh about 150 pounds.

DISCOVERY OF THE CINCHONA ALKALOIDS

In 1745, Claude Toussaint Marot de Lagaraye of Paris, an amateur chemist, perceived the deposition of a salt from an extract of Cinchona bark. In 1785, S. F. Hermbstadt of Berlin found this to be the calcium compound of an acid, which was established as kinic acid in 1790 by Frederick Christian Hofmann, an apothecary of Leer, in Hanover.

In 1806, Vauquelin determined the chemical properties of kinic acid, and shortly afterwards Liebig determined its composition. In 1811, Gomez, a Portuguese physician, obtained cinchonine in crystalline form. In 1820, Pelletier and Caventou discovered the new alkaloid quinine, but could not isolate it as crystals. Cinchonine sulfate was found to be as effective as quinine sulfate for relieving malarial fever, and was first prepared in the United States in 1823.

Quinidine was discovered by Henry and Delondre in 1833. Winckler discovered paracine in 1845, and cinchonidine in 1847. Oswald Hesse discovered paytine (1870), quinamine (1872), cusconine (1877), cusconidine (1877), conquinamine (1877), homocinchonidine or cinchonicine (1877), cuscamine (1880), cuscamidine (1880), cinchamidine or hydrocinchonidine (1881), and in 1876 he reanalyzed aricine which had been discovered in 1829 by Pelletier and Coriol. Arnaud obtained cinchonamine in 1881, and D. Howard homoquinine in 1882. Since 1882, fourteen other alkaloids of cinchona bark have been discovered, namely hydrocinchonine, cupreine, quinicine, hydroquinine, hydroquinidine, chairamine, conchairamine, chairamidine, conchairamidine, concusconine, dicinchonicine, diquinicine, javanine, and paytamine.

MEDICINAL USES OF QUININE AND RELATED ALKALOIDS

Of all the alkaloids derived from Cinchona bark, quinine ($C_{20}H_{24}O_2N_2$) has been put to the most extensive use. It is a specific in malaria, destroying the malarial parasite in its asexual form. The gametocytes are not destroyed, but they are frequently so affected that they fail to develop within the mosquito. Oral dosage has been found to be very satisfactory. The National Malaria Committee has recommended for an acute malarial attack 10 grains of quinine sulfate three times a day for three or four days until the parasites disappear from the blood; this is followed by 10 grains each night for eight weeks. Quinine is also administered in 10-grain doses of the acid hypochloride every four hours between attacks, or 20 grains an hour or two before the attack is due. In 1937, the Malaria Commission of the League of Nations recommended a daily dose of 15 to 18 grains of quinine hypochlorate or 20 grains of quinine sulfate for five to seven days. The gametocytes are destroyed by the use of plasmochin, or ethylaminoquinoline tannate, an almost tasteless synthetic relative of quinine. It is also somewhat effective against the asexual form of benign tertian and quartan parasites, but not against those of malignant tertian malaria.

Quinine is strongly antiseptic. Due to its bitterness it may increase the appetite, but after it enters the stomach it lessens digestion. It is rapidly absorbed from the blood. In extremely heavy doses it causes dimness of vision, color-blindness, deafness, ringing in the ears, albuminuria, hemoglobinuria, and hematuria. Quinine favors low heat production and protein storage, whereas fevers involve high heat production and protein destruction.

Combined with urea hydrochloride, quinine is used as a local anesthetic in place of cocaine. In the bisulfate form it is used as a disinfectant. Quinine is also used in amebic colitis, pinworm infection, exophthalmic goiter, hemorrhoids, constipation, varicose veins, and pneumonia. It is also used to a limited extent in making polaroid glass, while relatively small quantities are employed in "eau de quinine" hair tonics.

Quinidine, cinchonine, and cinchonidine are also employed in medicinals. About 11,000 ounces of quinidine are used monthly for cardiac ailments in the United States. Prior to 1942, the cinchona alkaloids were employed in approximately the following percentages: anti-malarials, 25 per cent; cold preparations, 60 per cent; and other uses including quinine for hair tonics and quinidine for cardiac cases, 15 per cent.

Thus the bark of the Cinchona tree has contributed greatly toward the alleviation of some of man's most enervating afflictions. Who knows but that in the decades to come many other uses may be found for the Cinchona alkaloids, or perhaps some other hitherto-unknown bark may suddenly spring into prominence and world-wide fame due to the discovery of some marvelous properties. Let us hope that its history will be as interesting as that of Cinchona bark.

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DOES MOTHER NATURE PLAY FOR KEEPS?

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THE relationship of man to the physical world has undoubtedly constituted a basis for confusion and anxiety ever since man has possessed memory and the capacity to relate past experiences to new circumstances which might confront him. For several centuries, however, the human race has felt that the phenomena of nature occur in a causal sequence, and that the way for man to get along well in the physical world is for him to act in accordance with this sequence—whether or not the causal factor is really understood. The hope for a better adjustment between man and nature's pattern of causal relationship was as basic in the efforts of primitive man to influence angry gods through sacrificial ceremonies, as in the efforts of modern man to control atomic energy through laboratory research. The general idea that there are large areas of relationship between man and the physical world in regard to which man must adjust to a fixed pattern, rather than strive to establish or change a pattern, has been symbolized and epitomized through several centuries. The Fates of Ancient Greece

are illustrative from the standpoint of the Classical World. Statements such as the following are similarly illustrative from the standpoint of the present world: "time and tide wait on no man"; "as one sows, so shall he reap"; "as certain [to come] as death"; "into each life some rain must fall."

The relationship between man and the physical world has sometimes been likened to a game of life which man is forced to play—a game in which nature lays down the rules and "plays for keeps," and in which man fares best by learning the rules and humbly obeying them. On the other hand it has sometimes been urged that as man's knowledge and "control over nature" increase, a change occurs in the significance of the rules—and perhaps even in the way in which the rules become established. The present discussion aims to examine briefly the basis for the two views.

Perhaps one field in which the rules of nature have been considered quite rigid is that of health, longevity and death. The so-called allotted "three-score years and ten," has never been a reality for any large segment of the human race, but rather an achievement in enough individual instances so that it could exert social appeal as a goal toward which to strive. Statistics on death rates or on life expectancy—at different ages, offer a more realistic picture regarding man's longevity and death prospects in the current world. An examination of such statistics reveals three pertinent types of variation: (1) from one national group to another; (2) from one social group to another within the same nation; (3) from one decade to another within a particular social group. At some stages in cultural and scientific evolution, such variations might be thought of as being due to variations in nature's rules concerning life and health, or variations in the rigidity with which a personified nature sought to enforce them. If one explains the variations among the groups described on the basis of variations in applied science, is he saying that as man's knowledge increases he becomes able to force nature to change her rules—or to relax in their enforcement? At any rate applied science has for many people forced death to stay away longer than was the case in earlier generations, and probably has also reduced the number of days of illness to be endured between birth and death.

Another area of relationship between man and nature, in which it has been thought that man must conform to rigid rules laid down by nature, concerns time. Illustrative of the thought are such cultural accretions as the following: "time and tide wait on no man," "father time reaps his grim harvest," "lost time is never found again." In regard to time as in regard to longevity and death, one might ask: can man influence the operation of nature's laws? Within certain limits man can rather objectively measure the passing of time, we may be told, but he cannot alter the amount of it or the rate at which it passes.

Yet for man the passage of time is significant because of what happens to affect man "during the time" which passes. If one thinks of such aspects of the modern world as relate to means of transportation, the tempo of war, or the capacity of agriculture to produce food, it seems obvious that for man in the present-day world it is possible for much more to happen during a given unit of absolute time (hour, week, year) than was ever true in the past. Hence from the standpoint of events—of the experience which man has during time, time has been substantially "stretched out" by the efforts of man.

There is a rather obvious relationship between a "stretch-out" of time through man's influence in increasing the tempo of events, as noted in the two foregoing paragraphs, and what might be considered a different type of "stretch-out" of time through lengthening the span of life, as noted in earlier paragraphs. Certainly if a ten-year extension in the span of life can be attributed to applied science in the field of health, then man's accumulated knowledge has "stretched out" time—so far as lifetime has practical importance for man.

A somewhat flexible corollary to the con-

cept of nature's rigidity in regard to time, and to lost time in particular, is the concept of wasted energies, capacities and natural resources. Soil fertility is one type of natural resource in regard to which we in the United States have for several decades been cautioned from the standpoint of "consumption" and "wastage." Much of the same applied to certain types of fuels, minerals, and other ingredients of the earth's crust which are considered to exist in limited quantity, and on which industrialized man in a large measure depends for his livelihood. The thought runs thus: nature is not creating any more of these resources to supply man, when man has used up or wasted the supply that now exists.

No detailed analysis is necessary to see the influence of man's activity in "stretching out" the amount of service which man gets out of any one of the limited natural resources, if one compares present-day uses of the resource insofar as possible with the first use for which man appropriated the resource. Among the factors which produce "stretch-out" in the sense indicated, the following might be cited: invention which results in more economical extraction and utilization of the original item (coal, iron, oil); use of substitutes either alone or combined with the original item (alloys, substitutes for scarce minerals); replacement by more of the same item or ingredient (timber, soil fertility, fish).

From the two foregoing paragraphs it is apparent that what constitutes a "natural resource," whether limited or unlimited in natural supply, depends largely on the status of the sciences and the applied arts at the particular time concerned—i.e., the coal of Illinois or the oil of Oklahoma were not "natural resources" for the American Indians of the seventeenth century. Similarly in the pre-atomic age deposits of uranium did not constitute a natural resource of great importance.

If one follows the theme of illustrations used up to this point, the "rules of nature" seem less rigid and universal in the field of utilizing natural resources than in the field of time or the field of longevity and death. Even more elastic than "natural resources" is the human resource of intelligence. Psychology seems increasingly to be considering intelligence as a developmental product—developed as a normal biological organism has contact with people, books, pleasures, disappointments, etc. But one can be emphatic about the general importance of contacts for intellectual development, and still grant that there may be much leeway in regard to the specific types of contacts which yield fruitful results, or the time in life during which one should have those contacts. Moreover, if the idea prevails that contacts develop intelligence, an individual and his mentors can do much through conscious effort to foster the type of contacts which will develop his intelligence in a desired direction. The importance for intellectual development of such matters as general health and physical nutrition, are considered sufficiently obvious to need no elaboration here. The significant point for this discussion is that mother nature may set the rules for the development of human intellect, but man in the modern world exercises substantial influence on the way in which the rules apply in particular instances.

The theme of the foregoing discussion concerns the extent to which mother nature sets the pattern for human existence—lays down rules for the game of life, and overlooks or forgives no variance, but makes man pay for all infractions of the rules. It is of course as true now as ever, that every person who is born will eventually die—and that when death occurs it is as final as it ever was; that if one spends an afternoon at the movies, the horse races or a ball game, he cannot spend that some afternoon at work in an office, laboratory or field—that time spent in one activity (the lost time idea) cannot also be spent in some other activity; or even that the contact which one might have with another person under the conditions of a particular time,

place and social setting, can never be exactly duplicated. In these respects limits are set by forces which are at present beyond the control of man, but in the present world these limits exhibit considerable elasticity which makes it possible for man to adjust the limits for his own comfort. From the standpoint of the immediate material result at a particular time, it makes little difference whether the adjustment is regarded to be a result of learning to select from among different patterns which nature offers; to be a slight modification of nature's pattern; to be a sharing with nature in the development of a pattern which is comfortable for man; or to be the design of a pattern by man into which he draws the physical forces and materials of nature as he sees fit. To repeat, the immediate material outcome in a particular instance is the same, whichever of the foregoing views one might accept as an explanation of the occurrence of the particular phenomena. However, from the standpoint of the mental outlook of man in regard to possible future change, there is a substantial difference between looking for something which he thinks or hopes some other agency might have created, and feeling the assurance that he himself has mastered tools by which he can create. This difference in mental outlook is analogous to the difference between a primitive agriculture in which man roamed about in search of seeds and berries which had grown without any effort on man's part; and a modern agriculture in which man consciously engages in plant breeding, fertilizing, seeding and cultivating, with definite anticipation of a particular type of harvest at a particular time and place. Certainly man has a sense of control over results in the latter case which is lacking in the former.

The sense of power to control gives man confidence and stimulates effort at predicting outcomes. When such efforts at prediction become organized, reflecting a logical sequence from one intermediate stage to another, the result may be called planning. By disappointment and failure man learns that there are forces at work which he did not take into account. Over-confidence, self-respect and ego thus receive a set-back, on their general road toward expansion. But modern man has recorded evidence of numerous successes to his credit, and he tries again. Primitive man lacked this basis for confidence and hope, and was more timid.

To revert to the figurative implication in the opening thought of this discussion, a somewhat humanistic in contrast with a fatalistic over-statement of the relationship between man and nature might imply that nature plays for keeps when man allows her to do so. When man was strait-jacketed by the primitive ignorance in which mother nature set him adrift, he was clearly at the mercy of nature's rules, however whimsical nature's ways might have seemed to him. It is understandable that the idea of inevitability might emerge in regard to particular phenomena which repeatedly occur in about the same way, apparently without regard for man's efforts or hopes. When many generations come and go without much change in the character of man's efforts or of his working tools, and hence little change in his results, the idea of inevitability might well become imbedded in symbol and epigram, and be passed on from generation to generation as distilled wisdom of the ages.

However, as man gains knowledge and the confidence that he can force nature to do his bidding in making life more comfortable for him, nature does not play for keeps or call the rules of the game in the exclusive sense of earlier times. The fact that man to date may seem to have made little progress in one aspect of his relationship with nature, perhaps the most difficult relationship—longevity and death, should not be greatly discouraging. Definite encouragement lies in the achievements to date along other lines—particularly when we note that man has been working at the task of control for only a very short time, in comparison with the time during which

"natural laws" have operated on this planet—as suggested by geologists who venture to make estimates of the history of the earth.

With an increase in the tempo of change in relationships between man and nature, increasing alertness is necessary in order continuously to discern the new areas of relationship in which old patterns of expectation and of explanation are no longer adequate — because substantial bodies of recent evidence are thereby overlooked. The reiteration of epigrams—samples of wisdom distilled from the limited information of the past, may become a slogan technique which discourages man and thwarts his efforts to improve his status on earth. Lazy persons, and selfish persons who profit from the type of ignorance and the sense of human helplessness which slogan techniques can readily exploit, are potent forces for perpetuating the slogans.

For the general run of present-day mankind, however, a humanistic interpretation which encourages man and stimulates him to creative achievement, is much more fruitful than a fatalistic interpretation which places a cloud over man's aspirations and restricts the idea of achievement merely to exercising selection from an existing repertoire of finished work.

POINT OF VIEW OF THE STAFF OF THE DIVISION OF THE SCIENCES AT COLORADO STATE COLLEGE OF EDUCATION REGARDING THE PURPOSES OF SCIENCE EDUCATION AS PRESENTED TO THE MAJORS IN THE DIVISION

Members of Science Staff of Colorado State College of Education, Greeley, Colorado

INTRODUCTION

J. DARRELL BARNARD

THE professional destinies of those of you who are majoring in science are to a large extent determined by the points of view represented by the staff of the Division of the Sciences at Colorado State College of Education. The courses you are required to take in completing a major in science; the methods that will be used in teaching those courses; and the outcomes that you, as students, will be expected to achieve are determined by the educational point of view of the science staff. When you consider the hundreds of science teachers who have received their education at this institution and the effect that those teachers have had upon children all over the country, the responsibility that this staff has is indeed an important one.

At a staff meeting last spring it was decided that we were obligated to the students who are majoring in science at the Colorado State College of Education, to let them know what we believe regarding the purposes of science education and the way in which those purposes should be achieved. For that reason we scheduled a panel as the last of the series of science seminars held last summer.

It seemed that one way in which we might get over our ideas would have been to take up some of the so-called issues in science education, to analyze them, to discuss them, and then to say what we think should be done about the issues. We began planning the panel with that in mind. But, as we took up the issues in our first meeting, it became obvious that something was wrong. Problems that seemed to be issues

to some people, who had given thought to the improvement of science education, did not appear to be real issues to all of us. We found that there were even differences of opinion among the staff as to what were and what were not *real* issues in science education. As we argued pro and con; "cussed" and discussed, it became evident that we were getting nowhere. It was soon obvious that we needed to go back and examine our fundamental beliefs regarding the purposes of education and the ways in which they could be achieved. It was not possible for us to agree upon what constituted an issue in science education nor what should be done about them, if such issues did exist, without having some general staff agreement regarding fundamental purposes of education.

When we began examining our collective thinking on the matter, there was general agreement that the basic purpose of education was to help the individual live effectively in our culture. Of course this was a very general idea but it did suggest the first problem that we needed to consider very carefully, and that was, "What is the nature of our culture?" The second problem followed logically, "What must the individual be able to do in order to live effectively in this culture?" The third problem gets right home as far as you and I are concerned as science teachers, "What activities would you expect to see in a science classroom where the teacher is trying to develop the kind of person who could live most effectively in our culture?" These constitute the three problems that will be dealt with in our panel this morning.

The ideas that will be presented to you by members of the panel are those which have been developed by the cooperative thinking of the science staff of the Colorado State College of Education. The ideas were developed by the long, slow, laborious process of thinking problems through with each other. If you had dropped into the Little Lounge of the Faculty Club, on any one of several warm Tuesday evenings this summer, you would have seen us at work. At times you would have thought that we were getting pretty rough with each other. At other times you might have thought that we were a trifle silly—silliness often accompanies confusion. But on each occasion after more than two hours of this give and take you would have heard the staff unanimously agree that the chairman should write out what he thought the answers should be and submit them at the next meeting for approval. At the next meeting you would have seen us tear apart the material he had prepared and return again to cooperative thinking on basic questions. At times we became extremely discouraged about the possibility of ever coming out with anything that would be representative of the thinking of the staff on these general questions. But the process worked as it always will if we only give it an opportunity. It takes time. It takes the combined efforts of everyone involved. It is the only way in which the democratic process can operate. We believe it is the only way in which a group of teachers can attack their problems effectively.

As a staff, we feel that we have gained a good deal from working together on these problems. We have a better understanding of each other and of the ways of working together. Each of us feels more sure of the ideas that will be presented to you this morning because they are *our* ideas. They are ideas that have passed the test of our individual and group analysis and evaluation. They are the best that we can offer at this time. But, as we go on from here to evaluate our science program in terms of these ideas, they will undoubtedly be modified and improved. We believe that what we have to present this morning is only the beginning of a continuous program designed to improve science education at Colorado State College of Education.

This morning Dr. E. C. Harrah, whose field is zoology, will present what we as a staff consider the important characteristics of our culture. Dr. William Dunn, whose field is chemistry, will describe the kind of person who, we believe, can live most

effectively in our culture. Dr. Donald Decker, who works in science education, will describe science classroom activities which we believe will help develop the kind of person who can live most effectively in our culture.

WHAT IS THE NATURE OF OUR CULTURE?

E. C. HARRAH

DOCTOR BARNARD has told you of the plan that the science staff has set up in order that we might think our way through to some definite conclusions. The task that has been assigned to me is to point out a few of the elements of our culture that the science staff thinks outstanding and that we believe can be developed by educational processes. If science education is to be effective in directing the trend of our culture, science teachers must be aware of the best that is in our culture and point their teaching toward the accomplishment of growth in the direction of the best in our culture. The culture developed in the United States is centered around the worth and dignity of the individual as contrasted to the cultures of the totalitarian governments in which the state is supreme and the individual a pawn on the chess board of life.

The staff has agreed upon six things that we believe are good elements of our culture and that we think should be stressed in our teaching.

1. The individual is free to make intelligent choice. Since the choice of an individual must depend upon the interrelationship of human activities the individual should take into account cause and effect relationships in making his choice. After choice is made the individual must assume full responsibility for its effect upon himself and upon society.

Basically nations must be guided by the same principles. Today America is at the cross-roads. What choice shall we make, peace or war. The choice is ours; we may develop a tremendous war machine upon which the totalitarian states have depended without much success; or we can launch into a program that will ultimately produce a peaceful world.

2. Government of the people, for the people and by the people exists for the benefit of all individuals and must of necessity for the benefit of the majority place limitations upon the the choice of the individual. In our culture, government is for men; in fact, for all mankind and not by a small group for the benefit of the few.

The Hitler regime is an excellent example of government by men, not for men.

3. All material resources must be used to promote the welfare of the total group. One of the fundamental causes of strife between both individuals and nations is their inability to obtain the necessities of life. Every individual in our nation is inevitably dependent upon other individuals. Likewise no nation is self-sufficient and must secure from other nations certain vital materials in order to promote its economy. Oil, coal, iron, steel, nickel, uranium, to mention only a few of the world's resources, must be used to promote the technology of the whole world.

4. World peace is essential if the worth and dignity of the individual is to be maintained. War always forces many limitations upon the free choice of the individual. Freedom of speech, freedom of the press, freedom of vocational choice, freedom from fear, freedom from want are all restricted and even freedom of worship is oftentimes called into question in time of war. If freedom of choice is valuable in our culture, peace, not war, is essential and must be promoted in our culture.

5. Scientists must be allowed to function unhampered in an effort to discover cause and effect relationships. Science has developed as an important element in nearly all modern cultures. It has not always been directed to the discovery of cause and effect

relationships nor for the well being of mankind. However, it is difficult to conceive of our type of culture progressing very far without the aid of the technical instruments of science or without the method used by scientists to discover cause and effect relationships. The part that science and scientists played in the recent world struggle is in itself sufficient evidence to support the unhampered work of scientists in an effort to discover cause and effect relationships.

6. Organized public education must be continued as a means of developing the best that is in our culture of today. Organized public education for the masses in so far as the individual can profit by it, is a development of free society and is necessary to promote the best that is in our culture. In most other cultures only a few of the wealthier or more fortunate individuals have the opportunity of an education and consequently are in a position to exploit the masses for their own gain. If in our culture we maintain the worth and dignity of the individual we must use education to develop the best in our culture for the benefit of all mankind.

These are certainly not all of the desirable elements of our culture nor are they our culture as it is today but we as a science staff think these elements can and ought to be developed. We believe that science teaching of the right kind can and must make a definite contribution to the development of these and other factors of our culture in an effort to promote the best that is in a democratic society and to direct the trend of mankind toward brotherhood and peace.

WHAT MUST THE INDIVIDUAL BE ABLE TO DO TO LIVE EFFECTIVELY IN OUR CULTURE?

WILLIAM L. DUNN

DOCTOR HARRAH has just described for us some of the outstanding characteristics of our culture. Some of these are more evident to us than are others, but all of them represent the best which the society in which we live offers to a person in that society. Certain ones of these statements represent goals which we should like to attain more fully. For example, it is clear to the thinking person that technology, while it has raised the general standard of living to a level not known heretofore, is still not always applied in such a manner as to promote the welfare of all mankind. We do, then, realize that there are certainly very desirable characteristics of our culture which have reached fruition, and which should be preserved; there are others equally as desirable which need encouragement and leadership for their development; and although we have not dwelt upon them, there are also some factors which we shall discover need to be removed if we are to continue to improve our society.

All of us, as members of the society whose culture we have been describing, have some part in determining the direction of the development of that culture. We have already been reminded that this is one of its characteristics. What should a member of this society be able to do to help preserve the best that is now in our culture, to help develop the culture in the proper direction for its improvement, and to help determine what that is now present should be discarded or superseded by higher ideals?

Before attempting to answer these questions, I should like to point out that a person should act as intelligently as is possible. He should heed the admonition "that the moral obligation to be intelligent is as binding as the moral obligation to be good." This will mean that he will make the best possible use of the opportunities for learning which are at his disposal in the formal educational program, in the group—that is, the community—activities in which he may

join, and in the proper use of his leisure time. Concisely, it may be said that he points his learning activities in the direction which will be most effective for his development, in order that he may fulfill the obligation to act intelligently. Also he will maintain his mental and physical good health in order that he may realize the maximum achievement of which he is capable.

Reverting now to those things which he must be able to do, we may list for the effective individual some quite specific abilities which he should possess in order that our culture shall exemplify the best of which man is capable. These things may be conveniently grouped into four categories: the problem, the information, the conclusions, the action.

I. The Problem. Obviously, one is powerless unless he can recognize the problems which infest society. Frequently these are so covered up and we are so used to the covering that we do not realize that a problem exists. No better example of this can be cited than the attitude with which some of us view our racial tensions. How often have you heard someone—maybe even yourself—who lives in a section of the country in which racial frictions are neatly hidden by a well defined set of behavior patterns, say that there is no racial problem where he lives, and that if outsiders would let things alone, there would be no difficulties. He has become so accustomed to the cover that he does not realize that the dirt is hidden under the rug, and that he has been helping to keep it there. It is an old attitude of "What you don't know won't hurt you," but unfortunately it will. A wide variety of problems in our society will present themselves for recognition, such as the control of atomic energy, juvenile delinquency, minority rights, rights of labor, property rights, and availability of equal educational opportunity.

In addition to being able to sense the existence of a problem, he must, if he is going to be effective in advancing society, recognize the factors which have given rise to the problem and be able to state these factors in concise and definite terms. Without this ability, he will never be able to center the attention of other people on the factors involved, nor is he likely to be very effective himself.

II. The Information. The limitations which nature has imposed upon man's intelligence necessitates the bringing together of the best thought of many individuals in the solving of problems. The person, who, having recognized and outlined the problem, wishes to look for its solution, must be able to locate reliable sources of information relative to the problem, including evidence which may not bear out his own preconceived ideas. All of the available facts and best thinking of authorities must then be organized in order that they will point as clearly as possible to the best conclusions. This implies the possession of certain skills such as the ability to read and to put down clearly the information gathered either in the form of language or formulae.

III. The Conclusions. On the basis of the information assembled, the individual who is working to remove problem areas from our society, will formulate, to the extent that the evidence is complete, working hypotheses or conclusions relative to the true nature of the problem and its answer. For the solution of the problem, he will plan action which will test the validity of his conclusions and will, if the results indicate, revise his conclusions in the light of his experience and other new evidence which he may uncover.

IV. The Action. In planning his attack, the person whom we have been describing, will wish to survey the existing forces which he may use to help solve the problem. These may include organizations already functioning, governmental agencies, such institutions as schools and churches, and means of mass communication such as the press and radio. In many cases, it may

be necessary to set up organizations or otherwise to develop means of attacking the problem being studied.

In carrying out a program aimed at solving some of the problems which exist in our society and the elimination of which would make our culture more nearly the ideal which we like to picture, it would be well to point out that the individual who labors most effectively for this purpose will not only have accepted the responsibility to act intelligently, and be able to sense the existence of problems, to search for information to aid in their solution, to formulate usable hypotheses, and to plan action designed to alleviate these problems, but he will also find it necessary to be possessed of the inner resources which will keep him working on problems whose solution may seem to be far away and which repeated effort fails to achieve. Thus equipped, he will be effective in helping to preserve the best that now belongs to our culture, and in helping to advance it to higher planes.

WHAT KIND OF ACTIVITIES WOULD YOU EXPECT TO SEE IN A SCIENCE CLASSROOM WHERE THE TEACHER IS TRYING TO DEVELOP THE KIND OF PERSON WHO CAN LIVE MOST EFFECTIVELY IN OUR CULTURE?

DONALD DECKER

If these are the characteristics of the culture which should be maintained and improved, and if individuals must exhibit these behaviors in order to maintain and improve their culture, what must be done in the classroom to develop this kind of individual and to promote this kind of culture?

What questions can I use to determine whether or not I am developing this kind of individual and promoting this kind of culture?

The Problem

1. Do I help my students formulate worthwhile problems?
2. Do I help my students evaluate their problems in terms of social and personal needs?
3. Do I give my students an opportunity to discuss possible problems for study?
4. Do I present overview lessons to help my students recognize worthwhile problems?
5. Do I help my students make study guides to direct their learning?
6. Do I make provision for personal interviews about problems of individual interest?
7. Do I evaluate a student's ability to select a worthwhile problem as carefully as I evaluate his knowledge of facts?
8. Do I know the problems that are worthwhile for study?

The Information

1. Do I provide many different sources of information?
2. Do I help students select specific information from the sources?
3. Do I teach them how to determine whether or not the information helps answer a problem?
4. Do I develop with them the criteria for judging a source of information?
5. Do I help them understand the relationships among facts learned from experiments, reading, demonstrations, charts, interviews, and class discussion concerning the problems studied?
6. Do I help students evaluate their study guides as they gather information?
7. Do I help them determine whether or not they have adequate information before they try to answer the problem?
8. Can I do these things myself?

The Conclusion

1. Do I help students make conclusions on the basis of the information they have obtained?
2. Do I help them evaluate their conclusions?
3. Do I help them apply their conclusions to their activities?
4. Do I provide opportunities for them to evaluate their conclusions by experimentation, observations, authorities, reading, interviews, and writing?
5. Do I provide an opportunity for them to judge their previous actions by their present conclusions?
6. Can they make better conclusions when they leave me than when they came to me?
7. Do I evaluate their ability to make conclusions as carefully as I evaluate the number of facts they know?
8. Can I do what I expect them to do?

The Action

1. Are the problems my students study of the nature that action can be taken about them?
2. Are the problems of such a nature that the school or town newspaper can be used as an agency to promote action?
3. Are there any agencies in the community which would be interested in our conclusions?
4. Are the problems of such a nature that parents would be interested in them?
5. Are the conclusions of such a nature that school organizations could be used for action?
6. Are the conclusions of such a nature that county organizations could be used for action?
7. Are the conclusions of such a nature that they would provide the basis for cooperation with national agencies?
8. Are the conclusions of such a nature that personal action can be taken about them?

If you can answer each of these with the word, "yes," you are developing the kind of individual who will be equipped to maintain and promote the desirable characteristics of our culture.

Why is this true? There are four reasons:

1. If learning is for purposes, such as we have defined, the purposes can be accomplished only if the learner participates in the planning and the determination of the purposes, content, and method for learning.

   If you answered "Yes" to the 32 questions your students do have a share in planning and determining purposes, content, and method of learning.

2. If we expect students to accept the obligation to be intelligent, we must give them the opportunity to accept the obligation and we must evaluate how well they carry out their obligations.

   If you answered "Yes" to the 32 questions you can evaluate how well your students carry out their obligations to be intelligent.

3. If we expect students to use opportunities to educate themselves, we must provide the opportunity for them to learn how to educate themselves in our classrooms.

   If you answered "Yes" to the 32 questions you are providing that opportunity.

4. If we expect students to point their learning activities toward those life activities which are the most important for their development, they must have an opportunity to evaluate their learning activities in relation to their personal development and an opportunity to engage in those activities which will help them develop as they should.

   If you answered "Yes" to the 32 questions your students are pointing their learning activities toward their own development.

What relations do these ideas have to the culture in which we live?

If the characteristics that were listed were desirable for the culture of adults and worthy of maintenance and promotion, then they are worthy characteristics for the smaller more intimate cultures of our classrooms.

If you are promoting these characteristics of our culture in the classroom you can answer each question that follows with the word, "Yes."

1. Does every individual in the class know that I believe every individual in the class has worth and dignity?
2. Do I allow an opportunity for the free choice of worthwhile problems and activities, or do I always tell students what to do?
3. Do I promote the idea that the school and the classroom, as the government, exists for the benefit of all individuals?
4. Do I help students understand why limitations must be placed on those individuals who do not respect the rights of others in the classroom?
5. Do I promote the idea by practice that the equipment, as the resources of the country, belongs to everyone in the room?
6. Do I accept the responsibility that public education means opportunity for all?
7. Do I provide an opportunity for students to be free to discover cause and effect relationships and recognize the worthwhileness of being able to do so?

BOOK REVIEWS

Kunkel, Fritz, and Gardner, Ruth. *What Do You Advise?* New York: Ives Washburn, Inc., 1946. 313 p. $3.00.

This book is a guide to the art of counseling and is directed to teachers, social workers, vocational advisers, physicians, ministers, and parents.

Good counseling consists in more than giving information, advice, admonitions, and warnings. Good counseling helps the individual to find a new point of view. A good counselor first of all, needs to know how to counsel—how to help the individual discover his own possibilities and adjust himself to the necessities of our civilization.

What Do You Advise? stresses the "We—experience," when the individual at last realizes that he is no different from other people—that he is living *with* the world, not at odds against the world. The first half of the book is devoted to theory, the second half to case histories.

—R. J. A.

GRAY, J. STANLEY. *Psychology in Human Affairs.* New York: McGraw-Hill Book Company, 1946. 646 p. $3.75.

Psychology is becoming more and more *factual,* hence more and more a *science.* Students and teachers are interested in facts rather than in theories, in data rather than "isms" and speculation. Psychology is also becoming more *practical,* more useful and applied. It is also becoming *inclusive,* hence increasing in breadth and scope. This book emphasizes these three newer trends in psychology. College students will appreciate the down-to-earth functional approach. It will serve excellently as a text and also as a fine reference.

Eleven chapters have been contributed by specialists in the field. A part of the introductory chapter considers psychology in the pre-scientific era (astrology, phrenology, graphology, and physiognomy) and its earlier development. Then chapters are devoted to psychology in college life, child development, education, vocational guidance, human adjustment, mental illness, speech-correction, public opinion and propaganda, crime, music, art and leisure, industry, business, military affairs, and clinical practice.

—S. M. A.

JERSILD, ARTHUR T., AND ASSOCIATES. *Child Development and the Curriculum.* New York: Bureau of Publications, Teachers College, Columbia University, 1946. 274 p. $2.75.

This volume deals with the implications of the child development point of view and of research findings in the field of child development. The first chapter discusses the meaning of the child development approach. The second sets forth a number of principles of development that have implications for education. Four chapters that follow deal with the infant, the preschool child, the elementary school child, and the adolescent. At the end of the volume is a rather extensive bibliography for each chapter.

This book will be of great value to teachers, principals, supervisors, and curriculum directors.

—S. M. A.

SPERLING, ABRAHAM P. *Psychology for the Millions.* New York: Frederick Fell, Inc., 1946. 397 p. $3.00.

Psychology for the Millions has been widely acclaimed, and seemingly, deservingly so. It does give a rather extensive survey of the field in language that the average layman can understand. It also serves as a "refresher" for those who had a course or courses in psychology some time back. It is based on the investigations of many researchers in the field, but the contributions of the more popular expositors is not neglected by any means.

The treatise has been made as practical as possible, the numerous illustrations that add so much to the interest of the book, have been taken from the lives and experiences of individuals that many readers know from newspaper and magazine reading.

Many questions of why, what, who, when, and how are answered. Such aspects of psychology as spheres of psychological influence, man's eleven senses, individual differences, heredity vs. environment, instincts, psychology of childhood, emotions, typing and judging personality, motives in personality analysis, effect of endocrine glands, conflicts and adjustments in personality analysis, fear and personality, psychology of the psychotic personality, the intelligence quotient and personality, and the psychology of sex development and sex problems are the major problems discussed.

Both parents and teachers will find much useful material here described in understandable terms. Surely there are millions of Americans who would profit immeasurably from reading this delightful treatise.

—C. M. P.

SYMPOSIUM. *Health Interests of Children.* Denver: Denver Public Schools, Department of Instruction, 1947. 119 p. $1.25.

This is a research study of the health interests of 3600 pupils in the Denver Public Schools. The statement of interests as expressed by the pupils is supplemented by a survey of the opinion of parents and teachers. In addition to providing data on interests, the book summarizes health needs of children as identified by experts in the field of health and health education. It presents also in summary form those growth and developmental characteristics of children which relate most closely to their health interests and needs. All data has been organized according to the following eighteen areas of health: keeping physically fit, group health, cause of disease, protection from disease, structure and function of the body, dental health, good eating habits, selection and composition of food, stimulants and narcotics, rest and relaxation, personal appearance, personality development, social health, heredity and eugenics, first aid, home nursing, safety, and vocation in health.

The report is extensively illustrated. There are 267 graphs depicting in percentiles the trend of specific health interests of boys and girls through their twelve years of school life. There are also numerous other graphs. The appendix includes the health interest check list for pupils, parents, and teachers. Also there is a list of the 12 health items of greatest interest and the 12 of least interest to pupils for each grade level from four through twelve. Curriculum workers on both the elementary and secondary school levels, health and physical education teachers, and science teachers will find this the most important resources material that has appeared in this extremely important area. It is a most vital addition to the recent studies of the needs of youth.

—C. M. P.

Munn, Norman L. *Psychology—The Fundamentals of Human Adjustment.* Boston: Houghton Mifflin Company, 1946. 497 p. $3.25.

This is one of the best and most carefully prepared textbooks in the field of introductory psychology which has come to my attention. Combined with the *Instructor's Manual* ($1.05) and the *Student's Manual* ($1.00), it has sought to meet the needs of students and instructors in concrete ways. The text itself includes twenty-five *chapters* classified in seven *parts*. These *parts* discuss (1) scope and methods of psychology; (2) psychological development; (3) learning, remembering, and thinking; (4) motivation of behavior; (5) feeling and emotion; (6) knowing our world; (7) individual differences. Included in Part Six, one recognizes borrowed physical concepts; and in Part Seven, elementary statistics, and discussions of intelligence, aptitudes, and personality. All in all, it represents a distinct integration which should appeal to many students more than the older, more conventional texts. Illustrations are plentiful (225 in number) and the author has given particular attention to visual aids in instruction. He gives evidence of constant attention to the teaching function as a composite of *guidance* and *suggestion* as well as of *telling*. References and suggestions for further reading are profuse. Every chapter closes with a summary which the author suggests to read before and after the main body of the chapter.

In the *Instructor's Manual*, the author gives additional detail about topic organization, and supplements the text with further information and suggestions about apparatus, films, and other materials. Added also are a series of tests to be used in any way the instructor wishes. Noteworthy are tests on the films which may be shown. All tests are keyed.

The *Student's Manual* is a guide for study and includes for each chapter: (1) suggested exercises in the techniques of research and illustration; (2) techniques on the use of films; (3) questions for group discussions; and (4) self testing exercises. There is also a brief discussion of effective study procedures. Keys are given in the appendix for self scoring by the student.

The author is to be congratulated on this excellent attempt to apply the principles of psychology—teaching and learning—to this first course in psychology.

—A. W. H.

HOBGIN, H. IAN. *Peoples of the South Pacific.* New York: The John Day Company, 1946. 95 p. $5.00.

An Asia Press book and a John Day 20th Anniversary Book, *Peoples of the South Pacific* consists of 26 pages of textual material and 69 pages of fine photographs that were taken to represent native life as it really is. None of the photographs were posed, except for the close-up photographs. To secure natural photographs like these, the natives must have such confidence that they regard the cameraman as part of their everyday life.

The short introduction tells about the social organization of the village and farm life, marriage, agriculture, fishing, the markets, shell currency, feasting, dancing, music, warfare, and religious beliefs. The author has written several other books dealing with the Pacific. An anthropologist, he has for fifteen years been making expeditions among Pacific peoples, living in their villages and taking part in their daily activities and ceremonies.

F. M. D.

MYTINGER, CAROLINE. *New Guinea Headhunt.* New York: The Macmillan Company, 1946. 441 p. $4.00.

To paint primitive people and have a record of a kind of human being who is fast disappearing from the earth was an ambition of the author. *New Guinea Headhunt* is a narrative of her sojourn for that purpose. The author has done much reading in anthropology, has studied anatomy, and has made careful drawings of the skulls of different races. Only a few miles from Christian Churches and law courts in New Guinea, people are still eating one another and bagging human heads as war trophies.

Papua is the name given to the territory owned by Australia on the south coast of New Guinea. The author had a great ambition to paint the Papuans of the island of Yela. She describes them as, "the blue-blooded race of races," "probably the purest Papuans living;" hook-nosed, black-skinned, long-skulled and small of stature; evil-smelling, wet and sullen-eyed, and suspicious-looking. This the people who for centuries have refused to breed with other breeds, gorilla-armed, scrawny, pot-bellied, and ricket-legged from eating their own sago. This the ultimate in race exclusiveness, one of nature's few perfected experiments in human self-sufficiency." The author tells how they kill and prepare human flesh to eat. The author states that such customs as killing people to eat them can be "educated" out of a group in a very short time, but that such a degree of sensitivity as the Yelamen reveal in their manner of killing must be an inherent quality which it might take more than a generation to breed out.

F. M. D.

GILMAN, COBURN (Editor). *The Week-end Book of Travel.* New York: Robert M. McBride and Company, 1946. 352 p. $3.50.

The reader will like to select stories to read from the content page. The book is comprized of dramatic and entertaining contributions made to the monthly magazine *Travel*, selected by its editor, Coburn Gilman. Economists and geographers will be interested in the data learned from the story about The Billion Dollar Islands of Peru and their guano.

Here is a sample paragraph: "The Peruvian Current, generally spoken of as the Humboldt Current, is important to the hot, arid life of the South American West coast. This long, cool river within an ocean is so surfeited with marine animals along the Peruvian littoral that it outvies any other water. Its effect, then, on the bird life and on the production of Guano, and its use in fertilizing the arid lands it parallels, is an example of one of the most direct, distinctive and potent influences of environment. What the Nile is to the Egyptians the Humboldt Current is to the Peruvians." Also one learns about the horrible apprentice trade in Chinese once practiced there and about the cruel and inhuman treatment to which they were subjected. Next, I enjoyed reading *Toy Trains that Climbed the Rockies* and learned about Palmer and the narrow guage railroading bug which hit Denver. An amusing incident is given of an engineer who upon learning a stretch of tracks were unsafe, got off the engine and let the train amble across then boarded it on the other side after it had crossed safely.

Athens, Nepal, Holland, Arabia, Dutch Guiana, Guatemala, Japan, Korea, and our own southwest are some of the places and parts of the world to which a sojourn with this book will take you.

Such authors as Victor Von Hagen, who wrote *South American Zoo* and Attilio Gatti, author of *South of the Sahara* have contributions in this book of voyages, adventure and romance throughout the seven seas.

F. M. D.

CALDWELL, J. B. *Introducing Alaska.* New York: G. P. Putnam's Sons, 1947. 202 p. $3.75.

Anyone planning a trip to Alaska, or to hunt big game they should first read this very excellent book, for it is an accurate up-to-date picture of conditions, opportunities and what to expect in Alaska, with authoritative information on hunting, fishing, travel, costs, business possibilities, homesteading, farming, trapping, prospecting, lumbering, and fur farming.

This last frontier region of America will be one of the most traveled parts of the world as soon as highways and cars are more adequate. It is the airplane's own domain and Alaska will be more rapidly used and developed due to air transportation.

Geographers will be interested in the facts

given about the climate, the Eskimos, the abundant animal life and above all, the white inhabitants of Alaska.

The reader will learn that the huge Alaska brown bear is the largest carnivorous animal on earth. The grizzly closely resembles the brown bear but is not as large. The black bear is found in three-fifths of the total area of Alaska.

If one plans to hunt in Alaska—the habitats of brown bear, moose and deer, the kind of gun, bullets to be used, and many other facts are carefully told in the chapter on hunting. Names of guides are given in the back of the book. One should write and engage a guide several months ahead of the time one expects to hunt. For a successful hunt he should allow at least two weeks preferably longer, beginning when he arrives at the rendevous previously arranged with his guide. Inclement weather or other unavoidable delays may take up several days, and he should have not less than ten days of actual hunting time.

Those interested in the Arctic will appreciate knowing that sea ice becomes less salty with age. One-year-old ice may be melted and used for drinking water, although slightly brackish. Two-year-old ice is almost as sweet as rainwater.

Mr. Caldwell has done extensive research work on Alaska during the past decade, including extended personal trips throughout the Territory. He has talked with countless Alaskans in every field of endeavor, knows their prospects and the problems to be faced. His book is a thoughtful, factual presentation of a subject which is vitally important to the hundreds of thousands of Americans who will seek their future in Alaska and to the countless numbers that will vacation there.

There are four groups of very fine pictures of Alaska and an Appendix which contains information about exporting of game, game laws and bag limits, licenses; names and addresses of Alaska guides, ("The Alaska guide is a high-class outdoor man, very proficient in his work and a thoroughly dependable, enjoyable companion. Treat him as such and the Alaska hunting trip will be as successful as he can make it. It might surprise some outsiders to know that among Alaska's guides are authors or publishers of books, prominent professional men, and businessmen."), the approximate time each has served, and the guide district each represents; game to be found in each guide district; travel costs, hotels, a list of Alaska air carriers and other worthwhile information.

F. M. D.

Siedentopf, A. F. *The Last Stronghold of Big Game.* New York: Robert M. McBride & Company, 1946. 202 p. $3.00.

Siedentopf, an Englishman who lived in Colorado, spent fifteen years in the dark reaches of East Africa. A great hunter and naturalist, the author in writing this book places most emphasis upon the animal life. For example he describes the animals in their natural habitats and shows why some are feared by man or other animals. There are some animals that are such a hindrance and menace that their extermination will be a good thing for the further settlement and development of Africa.

In the hunt and the chase the reader thrills and lives with the hunter and naturalist in East Africa. Some animals well described by the author are the leopard, zebra, crocodile, rhinoceros, buffalo, lion, and the elephant.

The last stronghold of big game lies in Tanganyika Territory in East Africa. The time spent in reading this book offers an exhilarating escape into a primeval world as fascinating today as it was centuries ago. There are thirty-two pages of big game photographs.

"Killers Must Die," and "Hunted Hunters," are samples of chapter headings which will enlist the undivided interest of the reader.

E. D.

Rorty, James and Norman, N. Philip. *Tomorrow's Food.* New York: Prentice Hall, Inc., 1947. 258 p. $3.50.

This "choice" little book *Tomorrow's Food: The Coming Revolution in Nutrition,* catches the readers interest at once. Just what will the new foods be? Will we be not only better fed but better nourished? Were the Pioneers better nourished than we are today? If they were, why? First, I read the foreword written by Stuart Chase and I was surprised to read this statement, "Some day, not so far away in the Atomic Age, food, like air and water, is likely to go into the class of free goods. It is too important to be kicked around, doped and puffed and doctored by hucksters." Is it "hand writing on the wall" warning all in the food business and a prediction of what is to come if they do not heed. Why do we have Pure Food laws? Why do we spend large amounts of money for the inspection of food?

Next Appendix II "How to Eat Sensibly Without Vitamin Charts" arrests my interest. The generalizations or concepts I found in this division are: (1) Certainly lowered resistance follows faulty nutrition as night follows day. (2) The food processor's earn large profits for their mutilation of natural food patterns, which if left undisturbed are entirely right for our consumption and are not in need of being "enriched", "restored" or "fortified." Food so devoid of nutritional value as to require "restoration", "fortification", "enrichment" is not wholesome food. No bewhiskered food chemist can restore, fortify or enrich any fraction of a natural food pattern that has been devitalized by processing so that it will be identical with or superior to the natural food pattern. (3) The same dietary that contributes to a recovery from a disease will sustain one in a state of good health.

A list of processed foods appears on pages 235 and 236 and a list of natural foods of good

biologic value appears on pages 238, 239, and 240. Following this in Appendix II there is a bibliography of recommended books and a very full and complete index.

"Wanted: Another Harvey W. Wiley"—is one of the chapters in this book which every parent and provider of the family food should read. It is of significance and concern to all of us that "from the innocently perverse technological pioneering of the eighteen-eighties, which removed most of the food value and minerals from two-thirds of our American foods, the American diet has never recovered. Nutritionally the modern food technology turned out to be, not exactly a Frankstein, but a kind of institutional Dr. Jekyll and Mr. Hyde."

The prediction is made in this book that agronomic and nutritional science plus food technology can banish both hunger and malnutrition from the experience of our people almost as completely as bacteriologic science and public health administration banished yellow fever and cholera—and this within a comparatively few years.

F. M. D.

FISCHER, MARJORIE AND HUMPHRIES, ROLFE. *Strange to Tell.* New York: Julian Messner, Inc., 1946. 532 p. $3.75.

This is a series of seventy-two stories of the marvelous and mysterious all of them from foreign sources, and most of them translations. Familiar authors are included, but not their most familiar stories (Jules Verne, Sholem Asch, Maxim Gork, Thomas Mann, and others). Here is a variety enough to suit many different literary tastes.

E. D.

CARPENTER, IRIS. *No Woman's World.* Boston: Houghton Mifflin Company, 1946. 338 p. $3.00.

A war could be won—but it can still be lost. Here is an account of war and the men who fought it by a woman who was there every step of the way. The author, Iris Carpenter, was one of the foremost British journalists and radio commentators. She is also a beautiful blond who saw the war in the rough. As a reviewer, I hesitated to pick this book up and read it, but I am not sorry now that I did, and I urge women-mothers and wives all over the world to read this first-hand account of World War II, the story of the drive from England across the channel, through Paris and on into Germany. In Holland they found textbooks for sons of the National Socialist Party prepared for their use by the Nazis—history books which stated the end to the European Balance of Power, with Great Britain the chief power, a thing of the past. Their arithmetic problems instead of taking so many apples away from so many, it was so many tanks or guns stolen. And the thief was a Britisher or a Frenchman.

What mayor hid from the Nazis in a cupboard in his own home for two years yet aided the Allied cause? What peoples showed signs of the worst deprivation and starvation? What was hardest for the boys to face when once crippled and disfigured perhaps for life? What type of letters sent by wives to their husbands on the fighting front showed lack of understanding and care?

The Arnheim plan was to strike where it was thought the Germans were weakest, where the Siegfried Line petered out toward the North Sea, and that the easiest way into Germany was to strike North through Holland, across the Rhine, and push on to the Zuider Zee while turning east across the flat plains into the heart of Deutschland. It depended for success upon the continuation of the disorganization which had marked German operations since Falaise. Had it worked, it would have saved all the subsequent hammering through toughly defended sectors of the Siegfried Line, and thousands of Allied lives.

Unfortunately, disorganization no longer existed in the German High Command. Defending their home soil had hardened and co-ordinated Nazi armies until now they were a fighting force comparable to their Afrika Korps at its best. Twenty-eight hundred out of six thousand got back—is a statement which shows the stubborn fight the weary groups of Allies put up. This represented failure of a plan that might then and there have ended the war. Instead, it forced acceptance by us that the struggle must continue throughout the winter and following spring, to end only after costly battering through reorganized and immensely strengthened defenses.

Iris Carpenter, the author, was one of the first women to land in Europe after D-Day and covered the war from the front line from that time until V-E Day.

F. M. D.

LEE, JOSH. *How to Hold An Audience Without a Rope.* Chicago: Ziff Davis Publishing Company, 1947. 280 p. $3.00.

I read this book from cover to cover and enjoyed and profited from every page of it. I learned to know why Huey Long, Will Rogers, William Jennings Bryan, and Tom Hefflin were all considered great speakers. This is not a textbook, but a popular type book for the average reader, a book that a person can read right along and get the general principles of successful public speaking. It should be a "must" it seems to the reviewer, for those majoring in speech. Incidentally, the book is a biography of a man who believed it would be worthwhile for him to be able to speak effectively. Josh Lee became senator of the United States and more recently has been a member of the Civil Aeronautics Board.

Men in the field of Science at times find it difficult to speak before large audiences and certain problems confront them when they attempt to read papers. These problems are reviewed and helpful suggestions are given. The book is full of interesting stories and incidents for it was the privilege of Josh Lee to know a large number of prominent men in political life. *How to Hold an Audience Without a Rope* is a witty and pene-

trating discussion on the art of influencing others by what you say and the way you say it. For pure enjoyment, it is one of the most interesting books one happens across in a long time.

F. M. D.

RAKESTRAW, C. E. *Training High School Youth for Employment.* Chicago: American Technical Society, 1947. 217 p. $——.

Bridging the gap between school and employment has always been a puzzling problem for educators. Many educators believe that the best solution to this problem is the Cooperative Diversified Occupations Program. In this book are presented the guiding principles, essential factors, minimum standards, and educational philosophy on which a program is based. Included also are tested solutions of problems frequently encountered in the organization, coordination and administration of such a program. Considerable emphasis is placed upon the role the coordinator must play in uniting industry, schools, and the public in support of this program.

The selection and organization of related-study material is a major problem of any Diversified Occupations Program; the author gives actual procedures in the development of related study outlines for specific ocupations.

This book is packed with thoroughly tested methods and practical solutions of common problems. It should be studied by all progressive, secondary-school, vocational and academic educators who seek a solution to the problem of adequately serving the youth of today.

R. V. M.

MURSELL, JAMES L. *Successful Teaching.* New York: McGraw-Hill Book Company, 1946. 338 p. $3.00.

The author attempts to answer the question: What must any teacher do if his pupils are to learn well and are to achieve lasting, usuable, and meaningful results? The author tried to wipe his mental slate clean by supposing that nothing at all is known about what makes teaching successful. He assumes that all methods—progressive, conventional and otherwise—are equally unacceptable. He states that this assumption is not too difficult, for it is quite clear that good teaching is not a very common thing. With this basic assumption he turns to psychology to see what psychological knowledge can be applied to the practical teaching job.

Six sets of principles seem to bridge the gap between learning and teaching. In two chapters devoted to each principle (one on organization of learning and the other on the appraisal of teaching) the author elaborates how each specific principle helps to bridge the gap. The six principles are: the principle of context, the principle of focalization, the principle of socialization, the principle of individualization, the principle of sequence, and the principle of evaluation.

The author early raises the question of whether teaching should be judged by results in terms of the learning of subject matter or by results in the terms of the development of pupils as persons. He defines teaching as the *organization of learning.* Learning is well organized when it is richly meaningful to the learner. A compelling and convincing problem, an intelligible rather than a routine approach, and a solution in terms of insight is the clearly indicated pattern of successful teaching.

The author emphasizes the great importance of lesson planning saying in the first place that *planning is thinking.* Planning conceived of in this manner makes for good teaching and a good teacher. All good planning is a process of growth and it should center upon learning and its organization.

The author's discussion of the evaluation process of learning and of teaching is quite stimulating. Altogether this is about the best book on modern teaching that the reviewer has recently noted. It is highly recommended to both prospective and on-the-job teachers.

C. M. P.

Addresses and Proceedings of the Eighty-Fourth Annual Meeting of the National Education Association. Washington, D. C.: National Education Association of the United States, 1946. 528 p.

Since there was no general meeting of the National Education Association in 1945, due to wartime travel restrictions, this book covers the activities of the Association for the two-year period 1945–1946. It includes the proceedings of the twenty-fifth Representative Assembly held at Buffalo, New York, during July 1946. It also includes the minutes of all committee and board meetings, and a record of all activities of Association departments, committees, commissions and councils.

Much has been done by the Association to raise the status of teaching during the past few years. Those who are interested in the schools of the United States will be interested in this comprehensive report.

R. V. M.

DREIKURS, RUDOLPH. *The Challenge of Marriage.* New York: Deull, Sloan and Pearce, 1946. 271 p. $3.00.

This book deals with the psychological and social factors which are responsible for our present day confusion of sex, love, and marriage. The understanding of these factors will help the inidividual in his efforts to solve the common problems of marriage: choosing a mate, getting along together, sexual happiness, infidelity and jealousy, and the rearing of children.

Strong emphasis is placed upon the responsibility of each individual who, through his personal attitudes, not only determines his own marital happiness but also influences the development of the group in which he lives.

The author has had wide experience in the

practice of psychiatry, in the direction of child guidance clinics, and the teaching of psychiatry in Vienna, where he was a student and associate of Dr. Alfred Adler. He used many case studies as illustrations throughout the book.

R. V. M.

BURNETT, R. WILL. *Life Through the Ages.* Palo Alto: Stanford University Press, 1947. 48 p. $1.00.

This visual introduction to the story of change in living things is a delightful brochure in the Standford Visual Science Series published in cooperation with the Palo Alto Junior Museum. It is designed for young people with the hope that young people will find inspiration in the development of life through the ages. The epilogue continues with the thought of man's future, the wisdom and high dignity of man—his essential goodness—matched by his culpability, stupidity, wilfulness and self-destruction. Must human suffering exist in a world that guarantees him an endowment "Little below the angels?" The drawings, pictures, paintings, photographs and dioramas that appear in the book are those found in the Science Wing of the Junior Museum. The book is stimulating to those interested in science experiences for youth and to similar museums or those contemplating such constructive work as this in community centers as a part of the recreation centers.

G. O.

DEMING, HORACE G. *Fundamental Chemistry.* New York: John Wiley and Sons, Inc., 1947. 745 p. $4.00.

In this second edition of this well-known text, the author gives a vivid portrayal of the principles of chemistry, presented as a manner of thinking. This book is an appeal to college teachers to lay more emphasis on the topics in chemical instruction that are really fundamental and will teach the student to think about familiar chemical and physical phenomena. Among the new technical developments, notice is taken of nuclear transformation, nuclear fission, newly discovered synthetic elements and the production of antibiotics. According to the author, the book was made in the classroom and is the result of an experiment with 240 students, a group of students not majoring in chemistry. The book is so marked to enable students majoring in chemistry to do more than the limited amount intended for students who will have no further courses in chemistry. Recognition is also taken of students with high school chemistry and those without chemistry. There is plenty of information concerning new developments in chemistry but no illustrations or pictures of such industries. Historical incidents and industrial developments are but briefly indicated but this does not necessarily mean that they are excluded. The first chapter sets the key-note for the major emphasis of the book and chemistry as a part of general education.

G. O.

ECKERT, THEODORE E., LYONS, NARLEY K., STREVELL, WALLACE H. *Directed Experiments in Chemistry.* New York: College Entrance Book Company, Inc., 1947. 158 p.

This laboratory manual in chemistry provides the usual selection of experiments in a convenient form together with supplementary exercises, drill and review assignments.

G. O.

ABSTRACTS

JOHNSON, PHILIP G. "Adaptations of the Physical Sciences to the Needs of Secondary Pupils." *American Journal of Physics* 15:480–483. November-December, 1947.

The first part of the article traces the origin and development of the general science course, and its extension down into the grades. The growth and development of biology is next discussed. There follows a long discussion on trends in the secondary physical science courses, the attempts with consumer courses, applied science courses, fused physical science, and special wartime courses. A one year physical science course would seem to be the best solution for small high schools, with this type of course plus courses in physics and chemistry, and applied science courses in each in the large high schools.

GARRETT, A. B. "Proficiency in General Chemistry." *Journal of Chemical Education* 25:24–26. January, 1948.

For the past 18 years teachers in The Division of General Chemistry at The Ohio State University have been studying the problem of what to do with high school students who have had high school chemistry. They have developed a series of proficiency or placement tests to determine the students' proficiency in chemistry. Satisfactory performance on these tests gives the student five term hours of credit toward college graduation, the credit being designated proficiency or Em credit, i.e. credit by examination. About 5 to 15 per cent of the students are thus moved up to the second quarter course.

Statistical data show that the Em students do

much better work in the second quarter course than do the regular students—50 per cent of Em students making a grade of A as compared to 8 per cent of the regular students; 30 per cent of Em students made B; 20 per cent of regular students; 17 and 41 respectively per cents made C; 1 and 20 per cent respectively made D and 1 and 11 per cent respectively made F. The Em students become the best students in the University.

PALMER, E. LAURENCE. "The Finer Side of Life." *N.E.A. Journal* 37:36–37. January, 1948.

This is one of a series of articles on conservation. Cover, useful predators, clean waters, and comfortable places for living have been covered in previous articles. Beauty that makes life worth living is emphasized in this article.

JOSEPH, ALEXANDER. "A Tribute." *The Science Classroom* 27:1. February, 1948.

The author pays a well-deserved tribute to Dr. Morris Meister for thirty years (1918–1948) Editor of *The Science Classroom.*

MILLER, REX C. "High School Geography in Nebraska." *The Journal of Geography* 47:8–17. January, 1948.

The number of high schools in Nebraska offering geography has increased from 81 in 1942–43 to 240 in 1946–47. World Geography was offered in 215 schools and Economic Geography in 18 schools. The courses usually last for the entire year. Teaching preparation is woefully inadequate, 98 teachers never had a college course in geography, 31 had 1 to 2 hours, 17 had 3 hours, and only 3 teachers out of 240 had geography as a major teaching field.

SWEZEY, KENNETH M. "What Fabric Is That?" *Popular Science Monthly* 151:219–221. October, 1947.

This illustrated article describes various tests for determining the composition of fabrics and some of the surface-processing treatments used upon them.

SWEZEY, KENNETH M. "Chemistry Spins a Yarn." *Popular Science Monthly* 151:214–217. December, 1947.

Complete, illustrated directions for making viscose and acetate rayon are given in this article.

SWEZEY, KENNETH M. "Chemistry Predicts How Metals Will Act." *Popular Science Monthly* 152:232–235. January, 1948.

The illustrated article describes a series of experiments suitable for chemistry students. Experiments are based on the activity series.

SAMUELS, HARRY. "Machines that Destroy the Earth." *Popular Science Monthly* 149:132–135. November, 1946.

Intricate mechanisms in the Hayden Planetarium in New York depict five catastrophies that could wipe out the earth: (1) explosion of the sun forming a new star and vaporizing the earth; (2) the depletion of the sun's energy, leaving a dead, frozen earth (sun's temperature estimated to now be about 35,000,000° F. at its core); (3) collision of sun with another star, destroying the solar system; (4) crashing of a comet into the earth; (5) the earth's gravity could lure the moon close enough to explode and loose meteors to bombard us at speeds up to 45 miles per second (the moon will have to be about 15,000–20,000 miles from the earth.) None of these are probable except in an extremely remote future.

VISHER, STEPHEN S. "Climatic Changes in Indiana." *Proceedings of the Indiana Academy of Science* 56:201–205. 1947.

Indiana's climate has varied greatly. Indiana had three glacial periods and two interglacial periods. Corals indicate a warm climate in the remote past and the ice sheets are positive evidence for a cold climate. Salt beds indicate an arid climate at one time, but there have been quite wet times, too. At present the climate is humid. At present Indiana is not a windy state, but loose deposits in southwestern Indiana indicate a former windy period. Indiana had a mild dry period ending about 4,000 years ago and there are some indications a similar period began about a century ago. Weather bureau records available since 1871 indicated marked fluctuations in temperature, precipitation, and snow fall.

VISHER, STEPHEN S. "American Thunderstorms." *The Journal of Geography* 46:348–351. December, 1947.

About 40,000 thunderstorms occur on earth every day. Often they are accompanied by hail or tornadoes and always by lightning. Lightning kills about 500 people annually in the United States, and tornadoes kill approximately 200. Both hail and tornadoes cause much property damage, but on the whole thunderstorms are more of a benefit to the United States than a detriment. A series of four maps gives important data about thunderstorms. Most thunderstorms occur in the southeastern United States —90 in Florida annually and less than 5 along the Pacific coast. They occur more often in summer—mostly July, followed by June, August, and May. More also occur in the afternoon.

Science Service Staff. "Science Review for 1947." *Science News Letter* 52:389–396. December 20, 1947.

Highlights of the year's happenings in the world of science are summarized. Discovery that the sense of smell operates through odoriferous substances filtering out heat rays inside the nose may be ranked in future years as the top accomplishment of 1947. The other nine most important advances made by science as picked by Watson Davis, director of Science Service are:

2. Pilotless plane that crossed Atlantic untouched by human hands at control, 3. Attempts at artificial rainmaking through sprinkling dry

ice or water on clouds under certain conditions, 4. Synthesis of protein in long-chain molecules, promising new plastics of medical and industrial importance, 5. Interconversion of proton and neutron fundamental particles and smashing of many more elements yielding new isotopes and transmutations in world's highest voltage synchro-cyclotron, 6. Largest display of sunspots in over a century, 7. Use of streptomycin in tuberculosis treatment, 8. Development of jet bombers and higher speed jet planes, 9. Discovery of 10,000 year old Tepexpan man in Mexico, and 10., Camera that makes finished photoprint in one-step process.

VAN DE WATER, MARJORIE. "More Mouths Than Food." *Science News Letter* 52:250–251. October 18, 1947.

To prevent war the world needs fewer babies. Experts believe that a population race would be as dangerous as an atomic armament race. Each individual in the U. S. gets more than 3,000 calories a day, Russia 2827, China, 2201, and India 2021 calories. Population increases may lessen the present calorie intake. In the U. S. there are 4 acres of land under cultivation for each person, in Russia 2 acres, South America one and a half acres, and western Europe and Asia less than one acre.

YAHRAES, HERBERT. "Mysterious Liquid Acts Like Atoms." *Popular Science Monthly* 151:77–81. August, 1947.

Liquid helium at temperatures near absolute zero acts more like an atom than it does any other liquid. It is the oddest fluid, that man ever dealt with, and the coldest. At this temperature gold, an excellent electrical conductor, becomes worthless as such, while tin and lead, ordinarily worthless, become perfect conductors. Liquid helium can also run *uphill*. Liquid helium is colorless and odorless, and a red-hot poker thrust into does not cause it to fizz as other liquids do, because it is an excellent conductor of heat. Liquid helium does not obey the usual mathematical laws as do ordinary substances.

ARMAGNAC, ALDEN P. "The Truth About Germ Warfare." *Popular Science Monthly* 151:84–87. August, 1947.

Bacterial warfare may be as equally effective as atomic warfare. Today, any country bent on aggression could launch a germ offensive overnight. The United States is especially vulnerable for such an attack. About 21 known germs could be used. One is the germ of botulism, the deadliest stomach poison known to man. Measles, mumps, parrot fever, anthrax, pneumonia plague, influenza, melioidiosis (mysterious and usually fatal far Eastern disease), and meningitis are other potential bacterial warfare possibilities.

BULLARD, FRED M. "The Story of El Paricutin." *The Scientific Monthly* 65:357–371. November, 1947.

El Paricutin is the only volcano in the earth's history of which there is a complete scientific record (ever since its initial beginning in a Mexican cornfield February 20, 1943). The cone is now over 1700 feet high. Appreciable amounts of volcanic ash have fallen in Mexico City two hundred miles distant. Ash is six inches thick ten miles east of the cone. Lava flows have reached a distance of more than seven miles.

ARMAGNAC, ALDEN P. "Can Huge New Atom Guns Shoot Out Biggest Secrets?" *Popular Science Monthly* 152:113–119. January, 1948.

The synchro-cyclotron at the University of Chicago, biggest atom gun in the world today, has a power of 200,000,000 electron volts. Now work has begun in England on the parts for a 1,500,000,000 electron-volt accelerator for the University of Birmingham. Two proposed American machines will be mighteir—10 billion electron volts. One will be called the bevatron and the other a proton synchrotron. The magnet of the latter will weigh an estimated 12,000 to 13,000 tons. Then for the first time scientists will command a beam comparable to the cosmic rays that strike the earth. Energy may be changed into matter. Estimated cost will be about $15,000,000.

Anonymous. "Danger: 115 Volts." *Popular Science Monthly* 152:186–189. January, 1948.

This article explains what you should know about electric shock, when it is most dangerous, and how to keep off of the receiving end. In the home: don't use a hair curler near water, don't touch a light and a radiator, keep electricity (fan, radio, heaters, light cord, switch) away from the bath tub, don't touch water faucet while changing light globes. Never touch anything electrical with even slightly damp hands.

Anonymous. "Longer Life Span Ahead." *Science News Letter* 52:324. November 22, 1947.

The average life span in the United States is now 65.8 years, a gain of 16 years since the turn of the century. Within the next 10 or 20 years the span is likely to be increased to 70 years or over.

BIGELOW, KARL W. "How About General Education for Teachers?" *The Journal of General Education* 1:99–106. January, 1947.

Programs planned for the training of teachers must now give serious consideration to the place of general education in such programs. The author quotes from such reports as that of the Harvard Committee: *General Education In a Free Society*; Commission on Teacher Education: *The Improvement of Teacher Education;* Vol. VI of the Teachers Bulletin 1933, No. 10.; Harvard Committee, 1942: *The Training of Secondary Teachers*; Commission on Teacher Education: *The College and Teacher Education, State Programs for the Improvement of Teacher Education, Evaluation of Teacher Education, The Improvement of Teacher Education*; Southern University Conference and the Southern Association of Colleges and Secondary Schools: *A Unified Program of Teacher Education and Cer-*

tification in the Southern States. Professional and general education requirements are discussed. Recommendations range from 10 to 21 hours for professional courses and from one fourth to three-eighths of the time devoted to general education. With wise planning and guidance neither of these requirements need be regarded as excessive.

THONE, FRANK. "Man Outlives Animals." *Science News Letter* 53:58–59. January 24, 1948.

Despite legends to the contrary, only giant tortoises live longer than man. Elephants have a life expectancy of 45 and the oldest parrot on secord died at 54. The life span of wild animals is probably shorter than those in capitvity. The Galapagos tortoise is known to live more than a 100 years; another species, Marion's tortoise, holds the record at 152 years; the little Carolina box turtle has been known to live to 123 years. Snakes are fairly short lived, the anaconda having a record of 29 years, the cotton-mouth moccasin 21 years, most lizards less than 20 years, horses 15 to 35 years, elephants 45 to 60, lions 8 to 15 years.

SAYVETZ, AARON. "The Natural Science Program in the College of the University of Chicago." *The Journal of General Education* 1:131–135. January, 1947.

College students entering the first year are required to take a one year course in mathematics specially designed for the purpose of general education, followed by a three-year course in the natural sciences. A class in natural science has three one-hour discussion meetings and one two-hour laboratory period each week. The third year is being offered during the current academic year for the first time. The first year is based on physics and chemistry; the second year on physiology, evolution, and genetics, the third year first half on the atomic structure synthesis of physics and chemistry, and the last half year on psychology.

The reading matter of the course consists of original or research papers written by scientists for an audience of scientists. For example such treatises as Lavoisier's *Elements of Chemistry*, Archimedes *On Floating Bodies*, Galileo *Two New Sciences*, Harvey *On the Motions of the Blood and Heart*, Darwin *The Origin of Species*, Harrison *Experiments on the Lens in Amblystoma*.

FRENCH, SIDNEY J. "Science in General Education." *The Journal of General Education* 1:200–205. April, 1947.

After assessing the college's prewar experience of more than fifteen years with general education, the Colgate Committee on the Postwar College came to the conclusion early in 1944 that general education was not only worth keeping but worth improving and extending. The earlier Colgate plan involved five survey courses: physical science, biological science, social science, philosophy and religion, and fine arts. The major committee's judgment were: first their encyclopedic nature and emphasis on facts; and second, their tendency particularly after the publication of the Colgate series of textbooks for the courses, to become somewhat standardized and even regimented. The new approach in the sciences is the problem approach called Problems of Natural Science. The following problems were used in the first term of operation: Physical Science: Does the earth travel around the sun or the sun around the earth? How did the solar system originate? Where did the moon come from? What caused the Carolina Bays? Why does the temperature of the air decrease as one goes to higher altitudes? How can man get up in the air? How high in the air can we go? How fast can an airplane fly? What is combustion? and Where does atomic energy come? Biological Science: Are there any structural and functional features common to all plants and animals? How is the earth's food supply continually renewed? Does blood circulate? How is the constancy of the water content of the blood maintained? What causes rapid breathing during exercise? What is the work of the stomach? How are traits inherited?

PACE, C. ROBERT. "Evaluating the Outcomes of General Education. *The Journal of General Education* 1:125–130. January, 1947.

Evaluation of courses must vary with the purposes of the courses and the courses differ widely, as they should. Evaluation techniques might include tests, check lists, inventories, attitude scales, interest indexes, ratings, observations, interviews, questionnaires, etc. An evaluation program will not be complete until it has collected evidence from former students and graduates of the College.

Symposium. "Statistics of State Progress in Public Education. *National Education Association Research Bulletin* 35:115–175. December, 1947.

The status of public school support by state, local, and federal agencies is presented verbally, statistically, and graphically. It is literally crammed with interesting and significant information. If you want to know how your state compares with other states in financing education, you will find the information clearly presented here.

SUTTON, TRAVER G. "Rating Scale on Teacher Morale." *The Clearing House* 22:270–275. January, 1948.

This self-analyzing chart on teacher morale has three general propositions and fifteen multiple-choice questions, with values assigned for the answers, and a "grading" key. The three general propositions are: (1) As an educator, what is my attitude toward my principal, or immediate superior? How do I interpret my feelings about him? (2) An attempt to interpret my attitude and feeling about my teaching position. (3) Is your community a good place in which to teach?

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